Stereometry made easie:

OR, THE

DESCRIPTION and *USE*

OF A NEW

GAUGING-ROD

OR

SLIDING-RULE:

BY WHICH

The Content of any *Tun, Copper, Cask* or other Vessel, may be readily found, either the whole or any part thereof: The *Area's* of *Circles* in *Gallons* and *Barrels* being found by *Inspection* only.

ALSO,

The Extraction of the *Square* and *Cube-root*, Questions concerning *Interest* and *Annuities*, and many other Arithmetical Problems are hereby resolved without *Pen* or *Compasses*.

To which is added an APPENDIX,

Containing the Description and Use of another New Rule, very useful in Gauging of Worts, and resolving Questions in the Mensuration of *Solids* and *Superficies*. With a *TABLE* of the *Area's* of *Circles* and *Contents* of *Cylinders* in Ale Gallons: Calculated to every tenth part of an Inch, from 12 to 156 Inches Diameter.

By *THO. EVERARD*, Philomath.

London, Printed by *J. Playford*, for *R. Clavel* at the *Peacock* in St. *Paul's* Church-yard, and *C. Hussey* at the *Flower-de-Luce* in *Little-Britain*: 1684.

To the Right Worshipful,

Sir *Denny Ashburnham*, Barr.

Francis Parry,
Robert Huntington, } Esq;

Char. Davenant, D^r^ *of* Laws.

John Friend,
Felix Calverd,
Nathaniel Horneby, } Esq;

Chief Commissioners and Governours of His Majesty's Revenue of Excise within the Kingdom of *England*, Dominion of *Wales*, and Town of *Berwick* upon *Tweed*.

And to his much Honoured Friend,

William Strong, Esquire;

One of the Commissioners of His Majesty's Revenue in *Ireland*.

The ensuing Tract *is humbly Dedicated*,

By Tho. Everard.

Advertisement.

THE Instruments describ'd in this Book are only made by *Isaac Carver*, at the Sign of the *Glob* *Dial* in *Horsly-down*: Who also maketh all other *Mathematical* Instruments in Silver, Brass, Ivory or Wood.

6 B a

TO THE

READER.

Courteous Reader,

THE two Inſtruments here deſcrib'd, were firſt Compos'd for my own particular Uſe, without any deſign of making them publick: But the approbation they have ſince met with from ſeveral Ingenious Perſons (whoſe knowledge in the Mathematicks doth render them more Competent Judges than my ſelf) have induc'd me to think they might be very uſeful to others; which is the reaſon, and alſo the end of their being expos'd to publick view.

To commend the Inſtruments or the ſeveral Arts in which they are

uſeful were a needleſs work; and what I have written of their Uſe cannot (perhaps) more need an Apology for its Publication, than my ſelf want skill to make one.

I know here is wanting that exactneſs of Method, and aptneſs of Expreſſion, which a more Learned pen might have adorn'd it with.

But I have endeavour'd to make it plain and intelligible, and I doubt not the Uſe of theſe Inſtruments will be quickly attain'd, and eaſily remembred by any one who doth but carefully peruſe what I have written, beginning with *Numeration* on the Lines, and ſo proceeding to work *Multiplication* and *Diviſion*, with the following Problems in the third Chapter, which muſt of neceſſity be firſt underſtood by him that deſigns to be exact in the ſeveral Inſtrumental operations contain'd in the following pages.

And

And besides the Introduction (wherein *Decimal Arithmetick* is sufficiently explain'd) I have so stated most of the Questions, that they may be resolved either by the Pen or Instrument, and if the opperations by each be duly consider'd, the Learner will be confirm'd in the Use of both.

But seeing I have laid down some Rules for Cask-Gauging, which do not agree with what some have written on that subject, it may here pass for a necessary digression (if at least it be any) that I shew what reasons induc'd me so to do; in order to which, I shall here insert several Rules which others have given, and from thence make such Observations as tend to my present purpose, leaving the Reader to approve or disapprove of the Rules which I have given as he shall think fit.

Now ſeveral Writers (who have lately treated on this ſubject) do agreee that, a Cask (which is bigger in the middle than at either head) may be taken in any of theſe four Notions.

1. As the middle Fruſtum of a Spheroid.

2. As the middle Fruſtum of a Parabolical Spindle.

3. As the middle Fruſtum of two Parabolical Conoids abutting upon one common Baſe.

4. As the middle Fruſtum of two Cones abutting upon one common Baſe.

[*Note*, A Cask which is the middle Fruſtum of a Spheroid may be repreſented by the outermoſt Lines in Figure 21th. and this will contain more than any of the other three.

And if a Cask be the Fruſtum of two Cones (which is ſeldom or never ſeen) it may be repreſented by Figure the 21th. ſuppoſing the prick

prick Lines *and*, to represent the staves of the Cask, which being strait from the Bung to the Head, this Cask will not contain so much as any of the other three: All other varieties that can happen will fall betwixt the Spheroid and Frustum of two Cones, and the Frustum of a Parab. Spindle being very near a Spheroid, may be represented by Figure 22th. the Frustum of two Parab. Conoids may be represented by Fig. 19.]

Now to find the Content of a Cask in each of these Notions: *Dary* in his *Compleat Ganger*, pag. 39. saith,

If you put D = *the Diameter of the Bouldge*, d = *the Diameter of either of the Heads*, S = D + d, *and* y = D − d; L = *the length of the Axis of the Vessel*, *and* C = *the Content thereof*, *the Demensions being taken in Inches.*

1. *If a Cask be taken as the middle Frustum of a Spheroid intercepted between two Planes Parallel, cutting the Axis at Right-angles:* Then;

$3.82) : 2DD + dd : \times L (= C.$

2. *If a Cask be taken as the middle Frustum of a Parabolical Spindle, intercepted*, &c. Then,

$3.82) : 2DD + dd - 0.4yy \times L (= C.$

3. *If a Cask be taken as the middle Frustum of two Parabolical Conoids abutting upon one common Base intercepted*, &c. Then,

$3.82) : DD + dd : \times 1\frac{1}{2} L (= C.$

4. *If a Cask be taken as the middle Frustum of two Cones abutting upon one common Base intercepted*, &c. Then,

$382) : SS - Dd : \times L (= C.$

In all these Cases the Content will be Solid Inches, but for the Content in Ale Gallons you must (as he saith) divide by 1077, instead of 3.82.

Now according to these Rules, if the Demension of a Cask be

Bung } Diameter { 34 }
Head } Diameter { 24 } Inches.
Length —— 48 }

The

The Content if taken as the middle Frustum of

			Ale Gall.
a	Spheroid . . .	is	128.71
	Parabolical Spindle		127.64
2	Parabolical Conoids		115.77
	Cones		113.55

Theſe Rules (and the Contents here found by them) are very true, a Cask being *ſtrictly* taken in each of the four Notions aboveſaid.

But yet they are not ſo well fitted to common practice as they ought to be, for in this Example the Content of a Cask taken as the Fruſtum of a Parabo. Spindle is but 1.07 Gallons leſs than the Content of the Fruſtum of a Spheroid, and the Content of the Fruſtum of two Parab. Conoids is but 2.22 Gallons more than the Fruſtum of two Cones. And I preſume that no man will pretend to diſtinguiſh which Notion a Cask muſt be taken in (whether as the Fruſtum of a Spheroid or of

of a Parabolical Spindle) when the difference is but 1 Gallon in 128. Moreover, here is 11.87 Gallons difference betwixt the Content of the Frustum of a Parabolical Spindle, and the Frustum of two Parabolical Conoids: So that I may modestly affirm, that there are many Gasks whose Content cannot be found by any of these Rules; for without all peradventure a Cask whose Diameters and Length are equal to those in this Example, may contain some certain quantity between 127.64 Gallons and 115.77: As suppose it were 123.22 Gallons, as will be found by my Rule in page 141.

I say if this Cask were Gauged by any of these Rules before cited, the Content will be at least 4 Gallons too much, or 7 Gallons to little.

Again, the same Author at the end of his *Miscellanies* saith,

If you put S = *the sum of the Squares of the Diamet ers of the Head and Bung,*

D = *their difference*, *and* Y = *the difference of the Diameters themſelves*, L = *the Length of the Veſſel*, *and* C = *the Content thereof*: Then,

1. *For the Fruſtum of a Spheroid*:

$$:1\tfrac{1}{2}S + \tfrac{1}{3}D : \times L = C.$$

2. *For the Fruſtum of a Parabolical Spindle*:

$$:1\tfrac{1}{2}S + \tfrac{1}{10}D : \times L = C.$$

3. *For the Fruſtum of two Parabolical Conoids*:

$$:1\tfrac{1}{2}S + 0D : \times L = C.$$

4. *For the Fruſtum of two Cones*:

$$:1\tfrac{1}{2}S - \tfrac{1}{2}YY : \times L = C.$$

Theſe four Rules you may alſo find in Dr. *Newton*'s *Coſmography*, pag. 81. And in each of theſe the laſt Product divided by 1077 quotes the Content in Ale Gallons, which in the Cask laſt menſion'd will be as followeth.

Middle

	Ale Gall.
Middle Fruſtum of a Spheroid	128.71
Middle Fruſtum of a Parabolical Spindle . .	118.37
Middle Fruſtum of 2 Parabolical Conoids .	115.77
Middle Fruſtum of 2 Cones	113.55

The firſt, third and fourth of theſe Rules produce the ſame Content as the other in the former Example.

But the ſecond Rule gives the Content of the Fruſtum of a Parabolical Spindle above 9 Gallons leſs than the former.

Mr. *Hunt*, in his *Guide* for the *Practical Gauger*, page 110. and alſo in his *Practical Ganging Epitomiz'd*, page 72. Gives this Rule for finding the Content of a Cask taken as the middle Fruſtum of a Parabolical Spindle.

To

To the doubled Area of the Bung Circle, add the Area of the Head Circle, and from the Sum ſubtract four times the Area againſt the difference of the Diameters, the Remainder is the Triple Area of a mean Circle, which Multiplied by $\frac{1}{3}$ of the Length, the Product is the Content.

Now let us find the Content of the Caſk above mention'd by this his Rule:

Bung Diameter 34 Area twice	3.2196 3.2196
Head Diameter 24 Area --	1.6042
Sum is . . .	8.0434
Difference of Diameter 10, its Area is .27851, this Multiplied by 4 gives . . .	1.1140
The Remainder is . . .	6.9294
This Multiplied by $\frac{1}{3}$ of the Length, *viz.* 16, the Product is 110.87 Gallons, the Content ſought, which is above 16 Gallons too	16 415764 69294 110.8704

little,

little, according to Mr. *Dary*'s Rule in his *Compleat Gauger.*

Nay Mr. *Hunt*'s Rule for the Frustum of a Parabolical Spindle makes the Content less by 2.68 Gallons than the Content of the Frustum of two Cones; which is absurd, for in a Cask which is the Frustum of a Parabolical Spindle, the Staves are Arching betwixt the Bung and Head as the Line *a o d* in Fig. 22. but in the Frustum of two Cones the Staves are straight as the prick Lines *a u d* in Fig. 22. 19 and 21.

I grant that in a Cask whose Diameters at Bung and Head differ but an Inch or two, Mr. *Hunts* Rule for a Parabolical Spindle will give the Content very near the truth, but that Rule which is true when the Diameters differ one Inch, will be true when the difference of Diameters is greater, as the Rule for a Spheroid will hold in all Spheroids as well when the Diameters differ

but

but 1 Inch, as when they differ 10 Inches.

The Rules which I have given in this Tract either by the Pen or by the Instrument, will hold in all varieties that do ordinarily happen, and I presume you will very rarely find a Cask whose Content cannot be found by one or other of them very near the truth. And that I might not be wanting to the meanest Capacities, I have added a *Table* of *Cylinders*, (the largest and I presume the most exact of any that is extant) by which the Content of any Cask or Tun may be found by Inspection, or at least by *Addition* (if the Diameter and length be given.)

But I have not so good an oppinion of what I have written as to believe it will please all, the Candid and Ingenious will (I doubt not) afford it a kind reception, which will very much oblige him that is

Thy real Friend,

Southampton,
Octob. 8. 1683.

Tho. Everard.

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Nay Mr. *Hunt*'s Rule for the Frustum of a Parabolical Spindle makes the Content leſs by 2.68 Gallons than the Content of the Fruſtum of two Cones; which is abſurd, for in a Cask which is the Fruſtum of a Parabolical Spindle, the Staves are Arching betwixt the Bung and Head as the Line *a o d* in Fig. 22. but in the Fruſtum of two Cones the Staves are ſtraight as the prick Lines *a u d* in Fig. 22. 19. and 21.

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THE CONTENTS OF THE BOOK.

Of Decimal Arithmetick.

Nu-

The Contents.

The Use of the Instrument in Arithmetick.

Of Superfices.

The

Of a Prism.

Of

Of a Sphere.

Of Pyramids and their Frustums.

The Use of the Instrument in Gauging of Tuns and Coppers.

To

The Contents.

To

Of Cask Gauging.

The Use of the Instrument in Questio[ns] of Interest and Annuities.

Of Simple Interest.

Quest. 2

Of Annuities.

Of Compound Intereſt.

THE

THE CONTENTS OF THE APPENDIX.

 The

The Use of the Instrument in severa[l] Problems concerning a Circle.

Prob. 10

Of Round Timber.

The

Of Square Timber.

Of

Of Brickwork.

he Uſe of the Rule in the meaſuring of Superficies, as

ERRATA

ERRATA.

Page.	Line.	Errors.	Corrected.
38	23	64	84
66	19	10512	10152
66	19	.00007471	.00007736
70	17	10.029	10.026
71	7	1002.9	1002.6
71	11	.2782	.27851
71	12	27.82	27.851
71	13	10.029	10.026
71	14	100.29	1002.6
72	1	9.273	9.273
72	2	27.82	27.85
79	6	ſides	dele
127	2	a Tun	the Tun
129	16	90	91
130	6	137.28	132.28
132	17	Dimonſtrations	Demenſions
140	19	Sphere	Spheroid
141	5	19	22
142	5	22	19
155	16	8.32	.832
155	19	8.32	.832
155	23	Spheroid	a Spheroid
158	5	*nc*	*n x*
149	5	678.7025	678.6025
149	7	903.7025	903.6025

In the APPENDIX.

Page.	Line.	Errors.	Corrected.
18	7	4.54491	3.54491
19	13	94.2776	94.24776
31	8	Circle	Circumferen[ce]
35	12	18.25	17.25
35	12	18	17
49	2	1.2	1.5
49	5	.15	1.5

THE

INTRODUCTION.

WHoever will rightly understand the Art of *Gauging*, or the *Use* of the *Instrument* here describ'd, ought in some measure to be acquainted with the Art of *Arithmetick*; at least with *Numeration*, *Addition*, *Subtraction*, *Multiplication* and *Division*, both in *whole Numbers* and *Decimal Fractions*; the latter of which (if well understood) is in this Art most useful.

And forasmuch as most of the *Problems* in this Tract are resolv'd by help of the *Line of Numbers*, the several *Uses* of which *Line* are render'd more facile and easie by the knowledge of *Decimal Arithmetick*: I shall in the first place endeavour to shew what a *Decimal Fraction* is, and also give some Rules and Examples, by which any person who does at all understand the vulgar *Arithmetick*, may in a few hours time thoroughly comprehend this.

A *Decimal Fraction*, is that, which by prefixing a point or a prick towards the left hand, its value is decreased from so many Units, to so many Tenth parts of an Unit, and if a point and a Cypher, or a Digit be prefixed it will then be so many hundred parts, and if a point and two Cyphers or Digits be prefixed, its value is decreased to be but so many thousand parts; as if you would prefix before the Figure 2, a point thus [.2] 'tis then decreased from 2 Units to 2 tenth parts of an Unit, and if you prefix a point and a Cypher thus, [.02] it is decreased from 2 Units to 2 hundred parts of an Unit. For,

As in *whole Numbers*, the value or denomination of places *increases* by Tens from the Units place toward the *left* hand, so in *Decimal Fractions*, the value or denomination of places *decreases* by Tens from the Units place towards the *right* hand, as in the following Scheme.

In which I have placed an Unit in its due place, and all the Figures towards the left hand (being whole Numbers) do *increase* by Tens, for the Figure 2 next the Units place is 2 Tens, (or 20) the next is 3 hundreds, and the next 4 thousands, &c.

But

6	*Hundreds of Thousands.*
5	*Tens of Thousands.*
4	*Thousands.*
3	*Hundreds.*
2	*Tens.*
1	*Unit.*
.2	*Tenth Parts.*
3	*Hundred Parts.*
4	*Thousand Parts.*
5	*Ten Thousand Parts.*
6	*Hundred Thous. Parts.*

But all the Figures from the Units place towards the right hand (being Decimal Fractions) do *decrease* by Tens, so the Figure 2, towards the right hand, is 2 tenth parts, the next is 3 hundred parts, and the next 4 thousand parts of an Unit, each place towards the right hand being ten times less.

In *Decimal Arithmetick*, we always imagin (and it would be very commodious if it were really so) that all intire Units, Integers, and things are divided into Ten equal parts, and each of these parts so divided we call *Primes*, we also divide each of these *Primes* into other Ten equal parts, and every of these divisions we call *seconds*,

 and

and each of these being divided into T[en] other equal parts may be called *thirds*, a[nd] so by dividing the former, and subdivid[ing] these latter, we may run on *ad Infinitum.*

Let a Pound Sterling be given to be [de]cimally divided:

According to the notion premised, t[he] first division must be *primes*, the next divi[sion] *seconds*, the next *thirds*, &c.

So one Pound Sterling being 20 *s.* wh[ich] divided into Ten equal parts, one of th[ose] parts is one *prime*, and its value is 2 *s.* a[nd] will stand thus, [.1]; three *primes* or thr[ee] *tenths* of a Pound will stand thus, [.3] a[nd] its value is 6 *s.* Again one *prime* or . being divided into Ten equal parts, ea[ch] of those parts will be one *second*, or o[ne] *hundred* part of a pound, and is thus ex[pressed], [.01] and its value will be 2 d and $\frac{6}{10}$ of a Farthing; and if .01 be div[i]ded into Ten other equal parts, each [of] those parts so divided will be *thirds*, o[r] one *thousand* part of a pound, and will sta[nd] thus, [.001] and its value will be $\frac{96}{100}$ o[f] a Farthing.

The like may be understood of one pou[nd] *Troy* or *Averdupoize*, one Foot, one Gallo[n] or any other Integer or thing whatsoever.

A *Decimal* Fraction, whether it ſtand alone or be joyned with *whole* Numbers, is ever diſtinguiſhed from a *whole* Number, by a point or a prick before it towards the left hand, as in theſe Examples.

·4752 4·752 47·52 475·2

In Decimal Fractions the *Numerators* only are ſet down, the *Denominators* being known by the *number* of places in the *Numerator*, for if the *Numerator* conſiſt of but one place the *Denominator* is 10, if of 2 places the *Denominator* is 100, if of 3, a 1000, if of 4, 10000, &c.

Example.

$$\text{The \textit{Denominator} of} \left\{ \begin{array}{l} .2 \\ .25 \\ .051 \\ .0752 \end{array} \right\} \text{is} \left\{ \begin{array}{l} 10 \\ 100 \\ 1000 \\ 10000 \end{array} \right\}$$

As Cyphers *before* a whole number have no value, ſo Cyphers *after* a *Decimal* Fraction are of no ſignification, and therefore will not increaſe the Fraction nor alter the *Denominator*, for .2 is two tenth parts, and .20 is no more.

Again, as Cyphers *after* a whole numb do *increase* that number, so Cyphers *befo* a Decimal Fraction do *diminish* the valu thereof, as in these *Examples*.

$$\left.\begin{array}{l} .5\\ .05\\ .005\\ .0005\end{array}\right\}\text{ is }5\left\{\begin{array}{l}\textit{Tenth}\\ \textit{Hundred}\\ \textit{Thousand}\\ \textit{Ten Thousand}\end{array}\right\}\text{ Parts.}$$

Here every Cypher added does remo the Fraction further from Unity, makin it Ten times less than before.

Addition and Subtraction of Decimal Fractions.

1. AS for the operation of *Addition* an *Subtraction* in *Decimals*, it is the *ve* *same* with the *vulgar*, there must only ca be had of placing *Units* under *Units*, an *Fraction* under *Fraction*, in their prope Ranks and Files.

For Example.

To ———— 376.43
Add———— 54.20
Sum is ——— 430.63

Again

Again,	To————	26.502
	Add————	310.005
	Sum is———	336.507

2. *Example in Subtraction.*

From————	763.25
Subtract————	296.31
Remains————	466.94

Or, thus:

From————	5.0525
Subtract————	4.8508
Remains————	0.2017

Note, In *Addition* there must ever be as many places of Fractions in the *Total*, as are found in *either* of the Sums *before* they are added together.

Multiplication of Decimals.

1. IN *Multiplication* both of *Decimal* Fractions and *mixt* Numbers, there are ever *two* Numbers given to find a *third* unknown.

One of the Numbers given (and it's no matter which) is called the *Multiplicator*, the other the *Multiplicand*, and the Number sought is called the *Product*, and this doth ever contain one of the Numbers given as many times as the other given number does contain Unity.

Multiplication of *Decimals* is perform'd after the *same manner* as in *whole Numbers*; for the Numbers being set down one under another, we proceed in the Multiplication as if they were all whole Numbers, only it must be observed (when the operation is finish'd) how *many* places of Decimal Fractions are contain'd in the *Multiplicator* and *Multiplicand*, for *so many* must be in the *Product*, as in these Examples.

Multiplicand ———	35.25
Multiplicator ———	7.24
	14100
	7050
	24675
	255.2100

Or, thus:

Multiplicand ———	6.75
Multiplicator ———	.25
	3375
	1350
Product ———	1.6875

2. When it happens (as it often does) that there are not ſo many *Figures* in the *Product*, as there are *Fractions* in the two Numbers to be Multiplied, you are then to place *Cyphers* before the *Product*, 'till the *Number* of places be equal, as in theſe Examples.

.04	.75	8.5
.6	.05	.005
.024	.0375	.0425

3. As *whole Numbers* are increaſed by Multiplication, ſo *Decimal Fractions* are hereby made leſs, for the *Product* is removed farther from Unity than either of the Fractions given to be Multiplied, as appears by the laſt Examples.

4. When a *Decimal* Fraction or *mixt* Number is to be Multiplied by an Unit with Cyphers (as 10, 100, 1000, *&c.*) you need only remove the point ſo many places towards the right hand, as there are Cyphers with the Unit, thus if .7562 be Multiplied

By	10	the Product will be	7.562
	100		75.62
	1000		756.2
	10000		7562

Diviſion of Decimals.

1. IN *Diviſion* there are *two* Numbers given to find a *third* unknown.

One of the Numbers given is called the *Diviſor*, the other the *Dividend*, and the Number ſought is called the *Quotient*, and this *Quotient* doth ever contain Unity as many times as the *Diviſor* is contain'd in the *Dividend*.

Diviſion of *Decimal* Fractions or *mixt* Numbers, is perform'd after the *ſame manner* as in *whole* Numbers, and it being in either, more difficult than any of the former Species, I ſhall here inſert a few Ex-

Examples together with ſuch directions as (I preſume) will render the work both plain and eaſie.

Example.

Let it be required to divide 32 *by* 51.2

In this Example the *Diviſor* (51.2) is *greater* than (32) the *Dividend*, therefore in this and all the like caſes you muſt place a competent Number of *Cyphers* behind the *Dividend*, which (if it be a whole Number, the) Cyphers ſo placed muſt be diſtinguiſhed there-from as Fractions, as here I put 4 Cyphers behind 32, and place the Numbers in this manner:

51.2) 32.0000 (

This done, I proceed to the diviſion (as if all were whole Numbers) and firſt ask how many times the *Diviſor* is contain'd in (320) the three firſt Figures of the *Dividend*, and ſeeing in this Example it is not contain'd in the three firſt Figures, it will therefore extend to the fourth place, under which I put a prick, and then ask how many

51.2) 32.0000 (6
128

many times 5 in 32: I find 6, I place 6 in the *Quotient*, and Multiply the *Divisor* by 6, subtracting the Product out of the *Dividend*, beginning my Subtraction at the place where I put the prick: Thus 6 times 2 is 12, from 0 I cannot, I borrow 2 and say 12 from 20 and there remains 8, which I place under the Cypher, again 6 times 1 is 6, and 2 I borrowed is 8, from 10 and there rests 2, which I place under the next Cypher before 8, as in the Example; then 6 times 5 is 30, and 1 I borrowed is 31, from 32 and there rests 1, which I set under 2; then for my new Dividend I bring down the next Cypher and set it behind the Remainder, and the Example will stand thus:

51.2) 32.0000 (6
1 280

Then proceeding in my Division, I ask how many times 5 in 12, I find 2 which I place in the *Quotient*, and say 2 times 2 is 4, from 10 and there remains 6 which I set under 0, again, 2 times 1 is 2, and 1 I borrowed is 3, from 8 and there rests 5, which I place under 8, then 2 times 5 is 10, from 12 and there rests 2, which I

51.2) 32.0000 (62
1280
256

place

place under 2, and to this Remainder I bring down another Cypher to make my new *Dividend*, so will the Example stand thus:

$$51.2)\ 32.0000\ (62$$
$$1\,280$$
$$2560$$

This done, I inquire how many times 5 in 25, and find 5 which place in the *Quotient*, and say, 5 times 2 is 10, from 10 and there rests 0; then 5 times 1 is 5, and 1 I borrowed is 6, from 6 and there rests 0; lastly 5 times 5 is 25, from 25 and there remains 0; and thus my Division is finish'd, and the Example will stand thus:

$$51.2)\ 32.0000\ (.625$$
$$1\,280$$
$$2560$$
$$0000$$

Now to know the value or denomination of places in the *Quotient* is the only difficulty; for resolving of which there are several Rules; the most general is this following.

The *first* Figure in the *Quotient* is always of the *same* denomination with *that* Figure which stands (or is supposed to stand) over the *Units place* in the *Divisor*.

There-

Therefore place the *Divisor* (or suppo[se] it to stand) under the *first* Figures of t[he] *Dividend*, as it ought to stand if it we[re] to be subtracted therefrom, in this Examp[le] it will stand thus:

32.0000 (.625
512

By which it appears, that the *Cyph[er]* which stands over the *Units place* in t[he] *Divisor*, is the place of *tenths*; I therefo[re] conclude, according to the Rule above give[n] that the first Figure in the *Quotient* must [be] of the *same* denomination, (*viz.*) *tenths*; therefore put a prick before it, so will t[he] *Quotient* be .625:

And for the same reason, if the *Divis[or]* were 612, the *Quotient* would be .0625 for in this case the *Cypher* which is *suppos[ed]* to stand over the *Units place* in the *Divisor* is the place of *hundredth parts*; therefore put a Cypher before 6 in the *Quotient*, an[d] then the Example will stand thus:

32.0000 (.0625
512

In like manner if the *Divisor* were a Fraction, *viz.* .512, the *Units place* being

next

...t towards the left hand will stand under ... place of *Tens* in the *Dividend*, and so ... first Figure in the *Quotient* will be *Tens*, ... stand thus: 32.0000 (62.5

.512

This may be further illustrated by the following Examples:

.0512) 032.0000 (625
1 280
2560
0000

.04) 03.6 (90
00

.75.0375 (.05
000

2. In Division of *whole* Numbers or *mixt*, ... there happen to be a Remainder, you ...y bring down more Cyphers, and by ...ntinuing your Division, carry on the ...*otient* to as many places of Fractions as ...u please, four or five will be very near the ...uth, but two or three will be sufficient in ...ost Cases, Example:

6.26) 25.800000 (4.1214
760
1340
880
2540
36

3. When

3. When any Number (either *Deci* or *mixt*) is to be divided by an Unit with C phers as 10, 100, 1000, *&c.* you need o *remove* the prick in the Dividend, so m places towards the left hand as there a *Cyphers* with the Unit, supplying the *vac* places (if any be) with Cyphers.

Thus 756.2 divided by 10, is 75.6 divided by a 100 it will be 7.562, by 100 .7562, and if by a 10000 the *Quotient* w be .07562.

4. *Division* is *prov'd* by *Multiplicati* and *Multiplication* by *Division.*

To *prove Division*, Multiply the *Quoti* by the *Divisor*, and the *Product* is the *D vidend:* Thus, .652 (the Quotient in t first Example of Division) being Multipli by 51.2 (the Divisor) the Product is 32.00 (the Dividend.)

To *prove Multiplication*; divide the *Pr duct* by *either* of the Numbers given to Multiplied, and the *Quotient* will be t other Number given.

Thus if the last Product (*viz.*) 32.00 be divided by 51.2 the Quotient is .62 or if 32.000 be divided by .625, the Quo tient will be 51.2.

And hence 'tis evident, that Division is [al]so *prov'd* by Division: For if any Quotient [b]e made a Divisor, it will Quote the first [D]ivisor, Example:

1.8)	28.8 (16
	10 8
	00 0

16)	28.8 (1.8
	12 8
	00 0

5. Now for as much as *Multiplication* is [e]*asier* than Division; I shall here shew that [w]hat is perform'd by a *Divisor*, may also be [p]erform'd by a *Multiplicator*, and *how* such [a] Multiplicator may be found: Suppose I [w]ere to *divide* 900 by 25, the Quotient [w]ill be 36.

Now let it be required to *Multiply* 900 [b]y a certain Number that shall produce 36.

To *find* this Multiplicator, *divide* an Unit [w]ith Cyphers by 25, the *Divisor* propo[s]ed, the *Quotient* will be .04 the *Multipli[c]ator* sought; for 900 being *Multiplied* by .04 the *Product* will be 36, which was required.

Again,

Again, *having* a Multiplicator to *find* Divisor, this is but the *Converse* of the former, for if an Unit with Cyphers be *divided* by .04 (a *Multiplicator*) the *Quotient* will be 25, the *Divisor* as before.

6. A *Vulgar* Fraction is reduced into a *Decimal* by Division: For which the Rule is

Divide the *Numerator* (of the *vulgar* Fraction given) by the *Denominator*, and the *Quotient* will be a *Decimal* Fraction *equal* in value to the *vulgar* Fraction given. So $\frac{3}{4}$ reduced as aforesaid will be .75 Example.

$$
\begin{array}{l}
4)\ 3.00\ (.75 \\
\quad\ \ 20 \\
\quad\ \ 00
\end{array}
$$

Note, The *odd parts* of an Integer cannot be exactly reduced to a *Decimal*, for there will always be a *Remainder*, in such Cases carry on the Fraction to four or five places, it will be very near the truth. Example.

$$
\frac{4}{9} \qquad
\begin{array}{l}
9)\ 4.0000\ (.4444 \\
\quad\ \ 40 \\
\quad\quad 40 \\
\quad\quad\ \ 40
\end{array}
$$

7. To

7. To reduce a *Decimal Fraction* to the [kn]*own parts* of the *Integer :*

If the *Decimal* given be *part* of a *Pound* [S]terling, Multiply it by 20 (the *Shillings* [in] a Pound,) and the Fractions in the Pro[d]uct by 12, (the pence in a Shilling,) and [th]e Fractions in this Product by 4, (the [F]*arthings* in a Peny.) This done, the [wh]*ole* Numbers in the respective Products [sh]ew the *Shillings*, *Pence*, and *Farthings* [c]ontain'd in the Decimal given, and the [F]*ractions* in the last Product are Decimals [o]f a Farthing. *Example :* Suppose .25 a [D]ecimal Fraction of a Pound Sterling were [g]iven to be reduced, Multiply it by 20, [th]e number of Shillings in a Pound, the [P]roduct will be 5, *viz.* 5 *s.*

$$
\begin{array}{rr}
 & .25 \\
 & 20 \\
\hline
\text{Shillings} \text{ --- } & 5.00
\end{array}
$$

So the *value* of .60625 will be found to [b]e 12 *s.* 1 $\frac{1}{2}$ *d.* as appears by the following [E]xample:

$$
\begin{array}{rr}
 & .60625 \\
 & 20 \\
\hline
\text{Shillings} \text{ ——— } & 12.12500
\end{array}
$$

Shillings

Shillings ———	12.12500
	12
	25000
	12500
Pence ———	1.50000
	4
Farthings ———	2.00000

But the *value* of any Decimal of a Pou Sterling may be known very near by *I* *spection*; for the *primes* are *twice* so ma Shillings as they contain *Units*, the *secon* *ten* times so many Farthings, and the *thir* so *many* Farthings as they contain Uni *ferè*. And as for the fourths or fifths, there be any, their value is *inconsiderable* ordinary practice.

Note, In counting the Farthings in th seconds and thirds, when they are near 2 cast away 1, if near 48, cast away 2 Thus in this Decimal, *viz*. .124 the prim is 2 *s*. and the .024 less by 1 (accordin to the direction above given) are 23 Far-things: So the value of .124 is 2 *s*. 5¼ *d*.

Likewise .448 of a Pound Sterling equal to 8 *s*. 11½ *d*. for .4 is 8 *s*. and .04 less by 2, are 46 Farthings, that is 11½ *d*.

Als

Alſo, .45 is equal to 9 *s.* for .4 is 8 *s.* and 5 ſeconds being half a prime is 1 *s.* or 50 ..s by 2 is 48, the number of Farthings in 1 *s.* So that if any Figure in the ſecond place .. exceed 5, count it 1 *s.* and ten times ſo ..any Farthings as it contains Units above 5, ..ating 1 in every 24; thus, .598 is equal .. 11 *s.* 11 $\frac{1}{2}$ *d.*

If the Decimal given be part of a *Beer* ..*rrel*: Multiply it by 4, (the *Firkins* in a ..rrel,) and the Fractions in the Product .. 9, (the *Gallons* in a Firkin,) and the ..actions in that Product by 8, (the *Pints* .. a Gallon.) This done, the *whole* Num..rs in the reſpective Products are equal to ..*rkins*, *Gallons* and *Pints* contain'd in the ..ecimal propounded: Example.

Let .72 be a Decimal of a Beer Barrel to .. reduced as aforeſaid, it will be found .. be 2 Firkins 7 Gallons 7 Pints and .36 of .. Pint, as appears by the Work.

	.72
	4
Firkins ———	2.88
	9
Gallons ———	7.92
	8
Pints ———	7.36

But

But *these* and *many other* Arithmetic Questions may be more *readily resolved* by the *Instrument*, a discription of which is in the first Chapter of the following Discourse.

TEREOMETRY
MADE EASIE,
OR, THE
ESCRIPTION and USE
OF A NEW
GAUGING-ROD.

CHAP. I.

A Description of the Instrument.

THE Instrument consists of *two* Parts, the *lesser* fitted to slide in or upon the *greater*, and being duly applied to each other, appear as one intire Rod of about ½ of Inch Square, and 38 Inches long; which conveniency of Carriage (and some other son herein after mentioned) is put into a ne, which may also serve to walk with.

The

The principal Lines on the Instrum are those commonly known by the nam *Gunters Line*, or *Line of Numbers*, w are here distinguish'd one from another certain Letters, set at the end of the L towards the right hand.

Thus the Line D upon the Rule is *single Line of Numbers*, beginning at end of the Rule towards the left hand, from thence continued to the other end

The Line A upon the Rule, and also Lines B and C, upon the sliding Rod, called *double Numbers*, each being *two* L or Radius's of Numbers, the *first* begin at the *left* hand, and ending in the *m* of the Rule, *where* the *second* Radius gins, and is foom *thence* continued to *end* at the *right* hand.

The Line E upon another side of sliding Rod is called *Triple Numbers*, be *three* Radius's of Numbers, the *first* beg ning at the *left* hand, and the *third* end at the *right* hand.

This *Triple* Line is *equal* in length to *double* Lines, and *all* to the *single* Li for all the *five* begin and end at the *s* point.

The *Line of Numbers* is (now) ſo *well known* moſt perſons, that it may be thought a *fficient* deſcription to have only ſaid that *ſe* are *ſuch*.

But for as much as this Inſtrument may be eful to ſome who (I preſume) do not yet ow what the *line of numbers* is, I ſhall there- re endeavour to explain it as followeth.

The *Line of Numbers*, is a Line of Geo- etrical proportions, divided firſt into *Nine equal* parts call'd *Primes*, which are di- nguiſh'd by Figures, 1, 2, 3, 4, 5, 6, 7, 8, 9; d then each of theſe *Primes* are ſubdivided o *ten* other parts (according to the ſame aſon) called *tenths*, and again, each of oſe *tenths* ſubdivided or at leaſt ſuppoſed be ſubdivided into *ten* other parts, ac- rding as the *length* of the Line will admit, here the *Line* D, being about 34 Inches ng, each tenth in the four firſt *Primes* is ally ſubdivided into *ten* parts, call'd *Cen- ms*, but from the Figure 5 to the end of e Line each *tenth* is divided but into *five* rts, and therefore each of thoſe parts ſignifie *two* Centeſms: Laſtly, each of ſe *Centeſms* is alſo ſuppoſed to be divided o *ten* parts, which by ſome are call'd *illians*; but a Line of this length will not mit of this laſt diviſion.

CHAP. II.

Numeration upon the Line of Numbers

THat *Numeration* may be the better understood, I shall begin with it upon the single Line D; upon which observe, that the Figures (1, 2, 3, 4, 5, 6, *&c.*) by which the *Primes* are distinguish'd, are all Arbitrary points, and may each of them represent so many intire *Units*, *Tens*, *Hundreds*, or *Thousands*. They may also represent so many *Tenth*, *Hundredth*, *Thousandth*, or *Ten Thousandth parts* of an *Unit*.

1. For *whole* or *intire Units*: Suppose the first *prime* or the Fig. 1. at the beginning of the Line, doth represent one *Unit*, then shall the Figures towards the right hand (*viz.* 2, 3, 4, 5, *&c.* to 10.) represent *so many* Units, and the tenths in each *Prime*, will be tenth *parts*, and the Centesms in each of those tenths will be *hundred parts* of an Unit.

Or, let 1 at the beginning of the Line represent 10 Units, then will each Prime forwards represent 10 times so many Units as the Figures express; thus, the Figures 2, 3, 4, 5, *&c.* will be 20, 30, 40, 50, *&c.*

An

And when one Prime represents 10 Units, each tenth in that Prime will be 1, and each Centesm in these tenths will be 1 tenth part of an Unit.

Again, let the first Prime represent 100, then the Figures 2,3,4,5, *&c.* will represent 200, 300, 400, 500, *&c.* and therefore 10 at the end will be a 1000, and according to this supposition 1 tenth in each Prime will be 10 Units, and in those tenths each Centesm will be 1.

For *Decimal Fractions:* Let 10 at the end of the Line (at D) represent 1, then each Prime towards the left hand will be .1, and in those Primes each tenth will be .01, and in these tenths each Centesm will be .001 part of an Unit.

To make this more plain, draw out the Sliding Rod 'till 1 at the *beginning* of the Line B stand exactly against 10 at the *end* of the Line A, for then you have a Line of Numbers four times repeated; upon which let 1 at the *beginning* of the Line A, represent 1 Unit; then shall 1 in the *middle* of the said Line be 10, and 10 at the *end* thereof (or which is all one at the *beginning* of the Line B) represent 100, and by consequence 1 in the *middle* of the Line B will be 1000, and for the *same* reason 10, at the *end* of the

the said Line (which is also the *end* of [the] *Rod*) will be 10000.

But keeping the Rule as it now stan[ds] let 10 at the end of the fourth Radius (... at B) represent 1, then shall each Prim[e] [in] the said fourth Radius represent .1, in [the] third Radius .01, in the second Radius .0[01] and in the first .0001 part of an Unit.

So will 2 in the first Radius be .0002, [in] the second .002, in the third .02, and [in] the fourth .2 parts.

The *Numbers* and *Divisions* on the Li[ne] being thus explained, it will not (I presu[me]) be difficult to find the point upon the Li[ne] where any Number given is represented.

Probl. I

Any Number being proposed, to find the p[oint] where the same is represented upon the L[ine] of Numbers.

AMongst the figures by which the Pri[mes] are Number'd, find the *first* Figure [of] the Number given; and for the *second* [Fi]gure thereof, count so many of the m[...] tenths towards the right hand as that [Fi]gure hath Units. Then for the *third* Fig[ure] count from the last tenth so many Cent[...]

[tha]t third Figure hath Units; likewise for [th]e *fourth* Figure, count from the last Cen-[tes]me so many Millions as the said fourth Fi-[gu]re hath Units; this done, you have the [poi]nt where the Number proposed is repre-[sen]ted. Example,

Let the Number given by 1895; for the [first] Figure thereof (*viz*. 1,) I count 1 at the [be]ginning of the first Prime on the Line D, [for] the *second* Figure I count 8 tenths next [wi]thin the said Prime; then from that tenth [I c]ount nine Centesms for the *third* Figure, [las]tly, for the *last* Figure 5 I count (by [est]imation) five Millions, which is half the [ne]xt Centesm; so I find the point a g will [re]present 1895, and by the same rule the [Nu]mber 1715 will be found at the point [..]g, and 1137 at the point B b: Hence [ob]serve,

1. That (on a Line of this length) only [th]e *four first* Figures of any Number propo-[se]d can be discovered, for if the Number [gi]ven were 189562, it would be represented [at] the same point where the former 1895 [w]as found (*viz.*) at a g.

2. That all Numbers which after the first [Fi]gure have nothing but *Cyphers* (as 20, 200, [2]000, &c.) are all represented at the *same* [p]oint.

 So

So 20, 200, 2000, are all represented the Figure 2, at the beginning of the seco Prime.

3. All Numbers consisting of *three* Figu and having a Cypher in the *middle*, are fou within the first tenth of that Prime, at wh the first figure of the Number given is foun Example, let the Number given be 30 for the *first* Figure I count 3 on the Li (which I find at the beginning of the th Prime) now there being a Cypher in the *se cond* place, I must not count any of the tent but for the *last* Figure 8, I count 8 Centes and that is the point which doth rep sent 308.

4. All Numbers consisting of *four* pla and having *two* Cyphers in the *middle*, m be sought betwixt the beginning of t Prime, unto which they belong, and t first Centesm of the same Prime; so 40 being given, the *first* Figure (*viz.*) 4, found at the beginning of the fourth Prim Now there being Cyphers in the second a third places, I must not count any of t tenths or Centesms, but for the *last* Figu 5, I estimate 5 Millions, which is about th middle of the first Centesm, and that the point where 4005 is represented.

Note, *Decimal* Fractions and *mixt* Numbers, are discovered after the *same* manner as whole Numbers, for if the first Number 1895, were 18, 95, it will be found at the same point (and by the *same rule* as the whole Number, (*viz.*) at a, g.

Probl. II.

Any point upon the Line being assigned, to find the Figures represented at the same point.

TAke the Figure which stands at the *beginning* of the Prime, within which the point is propounded, for the *first* Figure of the Figures required; then shall the *second* Figure sought contain so many Units, as there are tenths betwixt the beginning of the said Prime and the point given; likewise the *third* Figure required shall have so many Units, as there are Centesms intercepted betwixt the last of those tenths and the point given: And so likewise shall the *fourth* Figure consist of so many Units, as there are Millions between the last Centesm, and the said point.

Example, Suppose the *point* propounded were w g, because that point is within the *first* Prime, I take 1 for the *first* Figure required:

quired: And then finding 7 tenths betwixt the beginning of that Prime and the point given, I set down 7 for the *second*; then finding 1 Centesim between the last tenth and the said point, I take 1 for the *third* Figure: Lastly, conceiving five Millions to be comprehended betwixt the last Centesim and the point given, I take 5 for the *fourth* Figure required. This done, I conclude that the Figures represented at (wg) the point given, are 1715. In like manner if the point given were in the *middle* of the first Centesim in the fourth Prime, I take 4 for the *first* Figure; but here because I find no tenths betwixt the beginning of that Prime and the point given, I set a Cypher in the *second* place, then finding no Centesim, I write a Cypher in the *third* place; Lastly finding the point propounded in the middle of a Centesim, (which is supposed to be divided into ten Millions) I set 5 in the *fourth* place; this done, the Figures represented at the point given will be found 4005.

CHAP.

CHAP. III.

The use of the Line of Numbers in Arithmetick.

IN *Arithmetick* (saith Mr. *Wingate,*) there are *three* several sorts of *proportion*, *Arithmetical*, *Geometrical* and *Musical*.

Arithmetical, when *divers* Numbers being *compared* together retain amongst themselves *equal* differences, as these, 2, 4, 6, 8, &c. And this is either *continued*, as in the Numbers before propounded, or in these, 3, 6, 9, 12, &c. which is also called *Arithmetical progression*, or a *rank* of Numbers *Arithmetically* proportional; or *discontinued*, as in these 2, 4, 8, 10, or the like.

Geometrical proportion, is when *divers* Numbers being *compared* together *differ* amongst themselves, according to the same rate or reason, as these 2, 4, 8, 16, &c. for here, as 2 is half 4, so 4 is half 8, and 8 half 16; this is likewise either *continued*, as in those before propounded, or in these 1, 3, 9, 27, 81, &c. which are also call'd *Geometrical progression*, or a *rank* of Numbers *Geometrically* proportional; or *discontinued*, as

as in these 2, 4, 16, 32, for as 4 is double 2, so is 32 double 16, but so is not 16 being compared with 4.

Musical proportion, being of but little use in the present business, I shall not trouble the Reader with it: But if the two *former* (viz. *Arithmetical* and *Geometrical*) be *duly* consider'd, the following Problems may be the *better* understood.

Probl. I.

Having two Numbers given, to find a third Geometrically proportional unto them, and to three a fourth, and to four a fifth, &c.

Find *one* of the Numbers given upon the Line B, and set it against the *other* given Number on the Line A, then find the *same* Number upon B, (which was last counted upon A) and against it you have this *third* proportional upon A, and against the *third* upon B, is the *fourth* upon A; in like manner against the *fourth* upon B, you have the *fifth* upon A, *&c.*

Example, Let it be required to find a *third* proportional to *these two* Numbers 2 and 4, which may bear the *same* proportion to 4, that 4 bears to 2.

Draw

Draw out the sliding Rod 'till 2 upon B stand against 4 upon A, this done against 4 upon B is 8, the *third* proportional, upon A, and against this *third* (*viz.* 8) upon B, is 16 upon A, which is the *fourth* proportional: Likewise against 16 upon B, is 32 the *fifth*, upon A, and against 32 upon B is 64 the *sixth* proportional; but now proceeding forward I find that 64 upon B, will reach *beyond* the end of the Line A, I therefore seek 64 towards the *left* hand upon B, and against it I find 128 the *seventh* proportional; and so proceeding farther you may find the *eighth* to be 256, the *ninth* 512, &c. *Contrariwise*, if it were required to find a *third* proportional to the *same* Numbers 2 and 4, which may bear the *same* proportion to 2, that 2 bears to 4.

Set 4 in the second Radius upon A, to 2 upon B, then against 2 upon A (towards the left hand) is 1 the *third* proportional, and against 1 upon A is .5 the *fourth* upon B, also against this *fourth* (*viz.* .5) upon A is .25, the *fifth* proportional on B, &c.

In like manner, if the two Numbers given were 2 and 5; set 2 in the first Radius upon B, to 5 upon A, then against 5 upon B is 12.5, the *third* proportional, and against this *third* upon B is 31.25, the *fourth* upon

A,

A, &c. But if you would find a *third* pro-portional to the said Numbers 2 and 5, which may bear the *same* proportion to 5 that 2 bears to 5.

Set 5 in the second Radius upon A, to 5 upon B, then against 2 (towards the left hand) upon A is .8, the third proportional sought; also against this *third* upon A, is the *fourth* upon B, viz. .32, and against .32 upon A, is .128 the *fifth* proportional, &c.

Multiplication by the Lines.

Probl. II.

One Number being given to be Multiplied by another, to find the Product.

In Multiplication either of whole Numbers, mixt, or Decimal Fractions; the proportion is:

As 1, is to the Multiplicator;
So is the Multiplicand, to the Product.

And the *Product* of any *two* Numbers shall have so *many* places as there be in *both* the Numbers given, except when the *lesser* of them do *not* exceed so *many* of the *first* Figures of the Product; then it will have *one* less.

1. Example

1. Example; *Let it be required to Multiply 6 by 4.*

Say; [1 . 4 :: 6 . 24] which Analogy or proportion may be read thus, *As* 1 is to 4, *So* is 6 to 24.

Therefore, Set 1 upon the Line B, to 4 upon the Line A, and then against 6 upon B, is 24 upon A, which is the Product sought.

Note, The *Unit* or *first* term may be taken upon *either* of the Lines A or B, but the *first* and *third* terms must be counted upon *one* and the *same* Line, and the *second* on the *other* Line, where the *fourth* will also be found.

The Letters A and B, may serve to distinguish the Lines.

2. Example; *Let the two Numbers given be 68 and 26, to find the Product.* The proportion is, [1 . 26 :: 68 . 1768.]

Therefore,

Set 1 upon B to 26 upon A, then against 68 upon B, is 1768 on A, which is the Product sought; Or,

Set 1 upon B, to 68 upon A, then against 26 upon B, is 1768 (on A) the Product. Therefore it matters not *which* of the Number given be made the *Multiplicator*; and *Note* also, that the Product hath as many places as are in both the Numbers given,

because

because the least of them (*viz.* 26) d
exceed so many of the first Figures of
Product, according to the rule before gi

5. Example: *Let* 68 *be Multiplied by*
The proportion is,

1 . 14 :: 68 . 952

Therefore,

Set 1 upon B to 14 upon A; then aga
68 upon B is 925 the Product upon A, a
here the Product consists of one place
than there be in the two Numbers give
because the lesser of them (*viz.* 14) do
not exceed so many of the first Figure
the Product.

Now that the Product last found is 95
and not 95.2 nor 9.52 will thus appe
Set 1 upon B against 14 upon A;

	A.		B.
And then against	2	is	28
	3		42
	4		56
	5		70
	6		64
	6.8		95.2

By this 'tis evident, that the Lines a
in effect a Table of Multiplication, fo
having

ing set 1 to the Multiplicator, against Multiplicand you have the Product; f 2 be Multiplied by 14, the Product 8; if 3, the Product will be 42; if 4, if 5, 70, *&c.* Hence I conclude, that he Multiplicand had been but 6.8, the duct would have been 95.2, but the tiplicand being 68, the Product must 952. for by taking away the prick, Fractions in each are made whole mbers.

When of *two* Numbers given to be Mulied, the *one* consists of *whole* Numbers *mixt*, and the *other* of *Fractions* only, e the *whole* or *mixt* Number the *Multi*-*cator*, and having set 1 against it, seek Fraction towards the left hand, for inst it you have the *Product.*

. Example: *Let the two Numbers be* 5 *and* .8:

et 1 on A, to 27.5 on B, and then against (which being *less* than 1 I seek towards left hand) on A is 22 the Product on B.

And notwithstanding a number of *more* n four places cannot be exactly expressed a Line of this length, yet the Product any Multiplication may be discovered to or *seven* places at least.

5. Example:

5. Example: *Suppose I were to Mul[tiply] 2482 by 54.* The proportion is,

1 . 54 :: 2482 . 134028

Therefore,

Set 1 on A to 54 on B, and then agai[n] 2 on A, is 108 on B: Now suppose,

$$2 \text{ be} \begin{Bmatrix} 20 \\ 200 \\ 2000 \end{Bmatrix} \begin{matrix} 108 \\ \text{will be} \end{matrix} \begin{Bmatrix} 1080 \\ 10800 \\ 108000 \end{Bmatrix}$$

So the Product will have six places, [and] against 2482 the Multiplicand, you [may] discern (upon the Line) the four fir[st of] them, (*viz.*) 1340, the two last may [be] found by Multiplying (in ones mind) [the] two last Figures of the *Multiplicand*, by [the] two last of the *Multiplicator*; for so shall [you] discover the two last Figures of the [Pro]*duct*, which in this Example will be 2[8] which placed behind the four first (*vi[z.]*) 1340, makes the Product compl[eat] 134028.

I might here add more Examples, [but] these already given may serve, they con[-] taining (I hope) sufficient directions [for] all the variety that can happen in Mul[ti]plication.

Divi[sion]

Division by the Lines.

Probl. III.

A Number being given to be divided by another, to find the Quotient.

IN Division both of whole Numbers and mixt, the proportion is,

As the Divisor is to 1,

So is the Dividend to the Quotient.

Which Quotient shall ever consist of (but) so many Figures as the Dividend hath more than the Divisor, except when the Divisor does not exceed so many of the first Figures of the Dividend; then it shall have one place more.

1. Example: *Let it be required to divide* 24 *by* 4: The proportion is,

4 . 1 :: 24 . 6

Therefore,

Set 4 upon B to 1 upon A, and then against 24 upon B, is 6 upon A, which is the Quotient sought.

2. Example: *Let it be required to divide* 1768 *by* 26: The proportion is,

26 . 1 :: 1768 . 68

There-

Therefore,

Set 26 upon B, to 1 upon A, and th against 1768 upon B, is 68 (the Quotie upon A.

3. Example: *Suppose* 952 *were to be di ded by* 14: The proportion is,

14 . 1 :: 952 . 68

Therefore,

Set 14 upon A, to 1 upon B, then agai 952 upon A, you have 68 upon B, wh is the Quotient required.

Observe here, the Dividend hath but Figure more than the Divisor, yet the Q tient doth consist of two Figures, bec the Divisor does not exceed so many of first Figures of the Dividend, but in t first and second Examples the Quoti have but so many Figures as the Divide hath more than the Divisor, because t Divisor doth exceed so many of the fir Figures of the Dividend, according to t general Rule above given.

This shews (in all Cases) how ma Figures must be in the Quotient, the val of the first, of which may be found by th Rule given in the Introduction, page 13.

O

Or it will thus appear, that the Quo-
[...]nt in the last Example is 68, and not 6.8, [...] .68: Set 14 upon A, to 1 upon B,

	A.		B.
And then against	28	is	2
	42		3
	56		4
	70		5
	84		6
	95.2		6.8

This is but the Converse of the third [...]ample of Multiplication, for as by that [...]s manifest that if 2 were Multiplied by [...], the Product would be 28; if 3, it would [...] 42; if 4, 56, *&c.* So here it is evident [...]t if 28 be divided by 14, the Quotient [...]ll be 2; if by 42, it will be 3; if by 56, [...]s 4, *&c.* thus by reading on the proportion [...]om the Divisor 14: 28, 56, 70, *&c.* I find [...] last, that, if the Dividend were but 95.2, [...]e Quotient would be 6.8, but the Dividend [...]ing 952, the Quotient must be 68, for by [...]king away the prick, the Fractions in each [...]e made whole Numbers.

By these Examples it is also evident, that [...] *once* setting of the Rule we both *Multiply* [...]d *Divide*.

For

For if 14 be a Multiplicator, set 1 on B, against 14 on A; this done, against any Multiplicand upon B, you have the Product upon A, as appear'd by the third Example of Multiplication.

And without moving the Rule, if you suppose 14 to be a Divisor, then against any Dividend upon A, you have the Quotient upon B, as in the last Example of Division.

How by *any Divisor* to find a *Multiplicator* was shewn in page 17 of the *Introduction*; it may also be performed by the *Lines* more readily.

Thus *having* a Divisor to *find* a Multiplicator:

Set the Divisor given upon A, to 1 upon B, and then against 1 (towards the left hand) upon A, is the Multiplicator upon B. Example, suppose 25 were a *Divisor* given to find a *Multiplicator*.

Set 25 upon A, to 1 upon B, and then against 1 (towards the left hand) upon A, is .04 the Multiplicator sought.

By a *Multiplicator* to find a *Divisor*: This is but the *Converse* of the former, for having .04 a Multiplicator upon B, set it against 1 upon A, and then against 1 upon B, is 25 the Divisor as before.

Ri

Reduction by the Lines.

Probl. IV.

To reduce a vulgar Fraction into a Decimal.

Set the Denominator (of the vulgar Fraction given) upon A, to the Numerator thereof upon B, and then against [1] towards the left hand upon B, is the Decimal Fraction sought.

So $\frac{1}{4}$ will be found equal to this Decimal (*viz.*) .25: For,

As 4 upon A is to 1 upon B; *So* is 1 upon A to .25 upon B:

Also $\frac{21}{28}$ will be .75, for *As* 28 upon A, to 21 upon B; *So* is 1 upon A, to .75 upon B.

In like manner this vulgar Fraction (*viz.*) [illegible] is equal to this Decimal, *viz.* .60625, for, Set 960 upon A, to 582 upon B, then against 1 upon A, is .60625 upon B, and so for any other.

To

To reduce Shillings, Pence and Farthings [into a] *Decimal of a Pound Sterling.*

1. If they be Shillings only: Set 20, [the] Shillings in a Pound upon B, to 1 upon [A;] then against any Number of Shillings ([less] than 20) upon B, is the Decimal Fra[ction] upon A; thus 18 *s.* is equal to .9, 7[s.] equal to .35, 3 *s.* .15 of a Pound, &c.

2. If they be Shillings and Pence, t[urn] then all into pence; then set 240 (the pe[nce] in a Pound) upon B, to 1 upon A, the[n a]gainst any Number of Pence toward [the] left hand upon B, is the Decimal Fracti[on] upon A; thus, 5 *s.* 6 *d.* that is, 66 pe[nce] will be .275 of a Pound.

3. If there be Shillings, Pence and Fa[r]things, turn all into Farthings; then [set] 960 the Farthings in a Pound, upon B, t[o 1] upon A, and against any Number of F[ar]things towards the left hand upon B, is t[he] Decimal Fraction upon A; thus in 5 *s.* 6 [*d.*] 2 *q.* there are 266 Farthings, against whi[ch] (if the Rule be set as is above directed) you have .277 the Decimal sought.

Probl. V

Probl. V.

Decimal Fraction being given to reduce the same into the known parts of the Integer.

If the Decimal be part of a Pound Sterling: Set 1 upon B, to the Number of Shillings, Pence or Farthings contained in a Pound upon A, then seek the Decimal given upon B, (towards the left hand) and against it you have the Shillings, Pence or Farthings (respectively) contain'd in the Decimal given.

Example, Suppose .7625 were to be reduced into Shillings.

Set 1 upon B to 20 (the Number of Shillings in a Pound) upon A, then against .7625 upon B, (towards the left hand) is 15.25, that is, 15 *s.* and .25 parts of a Shilling, which is equal to 3 *d.*

2. To reduce the Decimal given into Pence: Set 1 upon B, to 240 (the Pence in a Pound) upon A, then against .7625 towards the left hand upon B, is 183, the Pence contain'd in .7625.

3. But if the Decimal aforesaid were to be reduced into Farthings.

Set

Set 1 upon A, to 960 (the Farthing[s in]
a Pound) upon B, and then against .[7625]
upon A, is 732, and so many Farthing[s are]
contain'd in .7625.

Again, suppose .7625 were a De[cimal]
of an Ale Barrel to be reduced into Ga[llons]
and Pints.

Set 1 upon A, to 32 (the Gallons [in a]
Barrel) upon B, then against .7625 [upon]
A, is 24.4, that is, 24 Gallons and .4 [tenth]
parts of a Gallon; to reduce this .4 [into]
Pints, set 1 upon A, to 8 upon B, and t[hen]
against .4 upon A is 3.2 Pints; So .7[625]
of an Ale Barrel is equal to 24 Gallo[ns 3]
Pints and 2 tenth parts of a Pints.

Probl. VI.

Three Numbers being given, to find a fo[urth] in a direct proportion.

THis is call'd the *Rule of Three Dir[ect]* and by the Instrument is wrou[ght] thus:

Set the first Number given upon B, [to] to the second upon A, and then against [the] third Number given upon B, is the fou[rth] Number sought.

Examp[le]

Example: *If* 8 *Quarters of Mault will make* [2]0 *Barrels of Strong Beer, How many Bar*-[re]*ls of such Beer will* 22 *Quarters make?*

Set 8 upon B, to 20 upon A, and then [a]gainst 22 upon B, is 55 upon A, and so [m]any Barrels will 22 Quarters make, and [ac]cording to this proportion 24 will make [6]0 Barrels, 28 will make 70, also 32 Quarts [w]ill make 80 Barrels, &c.

Probl. VII.

[T]o three Numbers given, to find a fourth in an inversed proportion.

THis is call'd the *Rule of Three Inverse*, in which observe, that if the *third* [n]umber be *greater* than the *first*, then will [th]e *fourth* be *less* than the *second*. And con-[tr]ariwise, if the *third* Number be *less* than [th]e *first*, the *fourth* will be *greater* than the [sec]*ond*, and in either Cases the Rule is [th]is:

Set the third Number upon A, to the [fir]st (being of like denomination) upon B, [an]d then against the second Number upon [A] you have the fourth upon B.

Example: *If 8 Men do any piece of wo in 9 days, In how many days can 12 Men the same work?*

Set 12 upon A, to 8 upon B, then agai 9 upon A, is 6 upon B, which is the answ For 12 Men may do the same work in days, that 8 Men do in 9 days.

But if the Question had been, *In h many days can 6 Men do the same work?* t Answer will be 12: For,

As 6 upon B, is to 8 upon A, *So* is upon B, to 12 upon A.

Probl. VIII.

To three Numbers given to find a fourth a doubled proportion.

THis is such a proportion as is betwe Lines and Superfiices, or between S perficies and Lines, and upon the Lines and D, both are wrought at once setti the Rule.

1. Of the proportion of Lines to S perfices.

Example: *If the Diameter of a Circle be Inch, and the Area or Content thereof 85398 of an Inch, What is the content of other Circle whose Diameter is 30 Inches?*

Set 1 upon D, to .785398 upon C, then ainst 30 upon D, is 706.8 upon C, and many Square Inches are contain'd in a rcle whose Diameter is 30.

2. If the proportion were of Superficies Lines, you have the Answer without oving the Rule.

Example: *If the Diameter of a Circle hose Area is .785398 be 1, What Diameter ll that Circle have whose Area is 706.8?* y,

As .78539 upon C, is to 1 upon D,
So is 706.8 upon C, to 30 upon D:
The Diameter as before.

Probl. IX.

three Numbers given to find a fourth in a tripled proportion.

THis is such a proportion as is between Lines and Solids, or between Solids d Lines: And upon the Lines D and E, th may be wrought at one operation.

Example: *If the Diameter of a Gl (or Sphere) be 1 Inch, and the Solid con thereof .5236 (parts of an Inch,) How m Solid Inches are contain'd in another Gl whose Diameter is 12 Inches?*

Set 1 at the beginning of the Line D, .5236 upon E, then against 12 upon D, 904.78 upon E, and so many Solid Inc are contain'd in a Globe whose Diame is 12 Inches.

Now if by the *Content*, it were requi to *find* the *Diameter*, you have your de without moving the Rule: For,

As .5236 upon E, is to 1 upon D,
So is 904.78 upon E, to 12 upon D:

The Diameter as before.

Probl. X.

Betwixt two Numbers given to find a m Arithmetically proportional.

THis is perform'd without the Ru for half the sum of any two Numb is an Arithmetical mean proportion betw them:

Th

Thus, if the two Numbers were 30 and ..., their sum is 50, the half is 25, the ...an sought.

Probl. XI.

...twixt two Numbers given to find a mean Geometrically proportional.

...Et one of the Numbers given upon C, ... to the same Number upon D, and then ...ainst the other given Number upon C, is ... Geometrical mean sought.

Example: *Let the Numbers given be 50 ...d 72, to find a Geometrical mean,* &c.

Set 50 upon C, to 50 upon D, and then ...ainst 72 upon C, is 60 upon D. So 60 ... a Geometrical mean betwixt 50 and 72.

Or thus,

Set 72 upon C, to 72 upon D, and then ...ainst 50 upon C, is 60 upon D, the mean ... before.

In like manner 95 and 47 being propoun...d, the mean proportional between them ...ill be found 66.82: For,

As 95 upon C, is to 95 upon D,
So is 47 upon C, to 66.82 upon D.

Or,

As 47 upon C, is to 47 upon D,
So is 95 upon C, to 66.8 upon D:

Probl. XII.

To find the Square Root of any Number under 1000000.

THe *Extraction of Roots* is one of t[he] *hardest* Lessons in *Arithmetick*, yet [by] help of this Instrument it may be perform[ed] with *less trouble* than any of the forego[ing] Problems: For if the Lines C and D, [be] applied one to another, so as 10 at the e[nd] of D, be even with 10 at the end of C; [I] say the Lines thus applied are like a Tab[le] shewing the Square-Root of any Numb[er] by Inspection only; for against any Nu[m]ber upon C, you have the Square-Ro[ot] thereof upon D, *Et Cont.*

Note, 1. When the Figures in the Nu[m]ber given are even, *viz.* when the Numb[er] consists of 2, 4, 6 or 8 Figures (being Int[e]gers) look the same in the second Radi[us]

f the Line C, and against it you have the Square-Root upon D: And in this case the said Root will ever consist of half as many Figures as the Number given.

Example: *Let 16 be the Number propounded*, I seek 16 in the second Radius upon C, and against it upon D, I find 4 the Square-Root required.

In like manner	5.5 48 886	is the Root of	30.25 2304 784996

2. When the Integers in the Numbers given are odd, *viz.* 1, 3, 5 or 7, seek it in the first Radius upon the Line C, and against it you have the Root sought. And in this case the Root will have half as many Figures as the Numbers given and one more.

Example: *Let the Number given be* 156.25, I seek this upon the first Radius of the Line C, and against it I find 12.5 the Root sought.

So also will	24 144 1000	be the Root of	576 20736 1000000

Probl. XIII.

To find the Cube-Root of any Number und
1000000000.

PLace the Lines D and E one by anothe so as 10 at the end of D, be even wi 10 at the end of E, this done against a Number upon E, you have the Cube-Ro thereof upon D, *Et Cont.*

Note, 1. When the Number given co sists of 1, 4 or 7 Figures (being Integer find it in the first Radius of the Line E, a against it you have the Cube-Root sough Example: Let the Number given be 337 I seek this in the first Radius in the Li E, and against it I find 15 upon D, whic is the Cube-Root of 3375, and so is 21 the Cube-Root of 9528128.

2. When the Number given consists o 2, 5 or 8 Integers, find it in the secon Radius upon E, and against it is the Ro sought. Example: Suppose 35.937 wer propounded, find this in the second Radiu of E, and against it is 3.3 the Cube-Roo upon D; in like manner is 275 the Cube-Root of 20796875.

3. Whe

3. When the Number given consists of 6 or 9 Integers, it must be sought in the third Radius, *&c.* For against it is the Cube-Root: Thus against 125 in the third Radius upon E, I find 5 the Cube-Root, and so likewise is 888 the Cube-Root 700227072.

Lastly, to know how many places of Integers must be in the Cube-Root of any Number given.

Put a point over the place of Units in the Number given, then omitting 2, point every third Figure toward the left hand, then tell how many points for so many places of Integers must be the Cube-Root consist of.

CHAP. IV.

Of a Superficies.

A *Superficies* is a Figure incompassed about with a Line or Lines, and is either Round or Angular.

2. A *Round Figure* is that which is contain'd by one Round Line, and is either a Circle (as Fig. 1.) or an Ellipsis (as Fig. 2.)

3. An *Angular Figure* is that which doth consist of three or more Angles, from the Number of which they are denominated; as a Figure of three Angles is call'd a Triangle, of four a Quadrangle, &c.

4. A *Triangle* is a Superficies comprehended by three Right-Lines (as Fig. 3.) of these there are six varieties, which I shall forbear to mention, they being all measured by one and the same Rule.

5. A *Quadrangle* is a Figure comprehended by four Right-Lines, and is either a Parallelogram or Trapezium.

6. A *Parallelogram* is a Figure whose opposite sides are parallel, having equal distances from one another in all places, and is either right or oblique.

7. A *Right-Angled Parallelogram*, is that whose Angles are all right, and is either a Square (as Fig. 5.) or an oblong (as Fig. 4.)

8. The *Oblique-Angled Parallelogram*, is that whose Angles are all oblique, and is either a Rhombus (as Fig. 7.) or a Rhomboides (as Fig. 6.)

9. A *Trapezium*, is a Quadrangular Figure, whose four sides are not all equal (as Fig. 8.)

10. *Figures* consisting of *more* sides than *four* are almost *innumerable*, but are reduci-

bl

le unto *two* sorts, *Regular* or *Irregular*; ither of which are also call'd *Polygons*.

11. *Regular Polygons* are such whose sides nd Angles are equal, they take their names rom the Number of their sides, as that of ive sides is call'd a *Pentagon*, (as Fig. 9.) hat of six sides an *Hexagon*, &c. Of *Irreular Polygons*, 'tis needless to say any thing, hey being measur'd after the same manner s a *Trapezium*.

I should next proceed to shew the Use f the Rule in the *measuring* of Superficies, ut it will not be altogether impertinent if first premise;

That every *Magnitude* must be measur'd y some *known* kind of Magnitude that is *Homogeneal* (or like) to it. A *Line* is measur'd by a *Line*, as one Lineal Inch, Foot r Yard.

A *Superficies* is measur'd by a *Superficies*, s one Square Inch or Foot, *&c.* A *Solid* s measur'd by a *Solid*, as one Cubick Inch, ne Cubick Foot, *&c.*

And when it is know how many { Lineal Inches or Feet, / Square Inches or Feet, / Cubical Inches or Feet, } are contain'd in a { Line. / Superficies / Solid.

Then

Then is the Quantity or Content o
either of these kind of Magnitudes said t
be known:

And the measures of *Capacity* commonl
used in *England* are of two sorts, eithe
wet or *dry*, for measuring of *Liquids*, as Bee
Syder, Wine, *&c.* (we take it for grante
that) there are *two* distinct Gallons, and
third for *dry* Comodities, as Corn, *&c.* th
Gallon for Beer and Ale, contains 282, fo
Wine 231, and for Corn 272 $\frac{1}{4}$ Solid Inches

See these more fully explain'd in the fol
lowing Tables, each of which doth shew
how many Solid Inches are contain'd in an
of the other measures expressed therein.

A Table of Beer Measure.

Inches.	*Pints.*	*Quarts.*	*Gallons.*	*Firkins.*	*Kilderkins.*	*Barrel.*
35 $\frac{1}{4}$						
70 $\frac{1}{2}$	2					
282	8	4				
2538	72	36	9			
5076	144	72	18	2		
10152	288	144	36	4	2	

Inches

A Table of Ale Measure.

…*ches.*						
…5¼	*Pints.*					
…0½	2	*Quarts.*				
…82	8	4	*Gallons.*			
…256	64	32	8	*Firkins.*		
…512	128	64	16	2	*Kilderkins.*	
…021	156	128	32	4	2	*Barrel.*

A Table of Wine Measure.

…*ches.*								
…8⅞	*Pint.*							
…7¼	2	*Quart.*						
…31	8	4	*Gallon.*					
…158	144	72	18	*Rundlet.*				
…553	504	252	63	3½	*Hogshead.*			
…404	672	336	84	4⅔	1⅓	*Tercion.*		
…106	1008	504	126	7	2	1½	*Pipe.*	
…212	2016	1008	252	14	4	3	2	*Tun*

…This Table shews that in 1 *Tun* there is …*ipes*, 3 *Tercions*, 4 *Hogsheads*, 14 *Rundlets*, …2 *Gallons*, 1008 *Quarts*, 2016 *Pints*, and …212 Solid *Inches*. The Tables for *Beer* and … are like this, and need no explanation.

CHAP.

CHAP. V.

The Use of the Rule in Measuring Superficies, and first of a Circle.

THe Area or Superficial Content of a Circle is found by knowledge of the Diameter or Circumference, I shall therefore first shew how by either of these to find the other.

Probl. I.

The Diameter or Circumference of a Circle either being given to find the other.

IT is prov'd by a Learned * Author that the Circumference of that Circle whose Diameter is Unity (or 1) is 3.1415926536; but for our purpose 3.141592, will suffice: Therefore, as 1 is to 3.141592 so is the Diameter of any Circle to the Circumference: By the Instrument thus,

* Foster's *Problem. Geomet. Vari. Propos.* 2.

So

et 1 on the Line A, againſt 3.141592 he Line B, this done againſt any Di- ter on the Line A, you have the Cir- nference on the Line B, and the contrary s: Againſt,

Theſe iameters	20	you have theſe Circ.	62.831
	30		94.247
	40		125.663
	50		157.079

Or Contrariwiſe againſt,

Theſe Cir- mferences.	20	you have theſe Diam.	6.366
	30		9.549
	40		12.732
	50		15.915

And ſo of any other.

Probl. II.

The Diameter of any Circle being given to nd the Area (or any part thereof) in Inches, Ale or Wine Gallons, and alſo in Ale or Beer Barrels.

1. For

1. *For the whole Area in Inches.*

THe Area of a Circle is equal to the [Square] or Rect-angle of half the Diam[eter] into half the Circumference, that is to [say,] If half the Diameter be Multiplied by [half] the Circumference, the Product will be [the] Area.

Thus, when the Diameter is 1, the Ci[r]cumference is 3.141592, the half of [it] is 1.570796, which Multiplied by [half] the Diameter, (*viz.* 5.) the Product will [be] the Area of that Circle whose Diameter [is] 1, (*viz.*) .785398.

The Areas of all Circles are in proport[ion] one to another, as the Squares of their Di[]ameters, (2. 12. of *Euclid.*)
Therefore, as the Square of the Diame[ter] of any Circle is to the Area of that Circ[le],

So is the Square of the Diameter of a[ny] other Circle to the Area thereof.

In the Circle above mentioned the Di[a]meter is 1, and the Area .785398: No[w] the Square of 1 being but 1 it must hold *As* 1 is to .785398, *So* is the Square o[f] any Diameter to the Area: So .785398 [is] a fixed Multiplicator, and if an Unit wi[th] Cyphers be divided by .785398 the Quo[]tie[nt]

t will be 1.27324 a fixed Divisor, and either of these fixed Numbers the Area ny Circle may be found, either by Multication or Division, if the Diameter be given. For if the Square of any Diter be

Multiplied	by	.785398	Prod.	is
Divided		1.27324	Quot.	

Area in Square Inches, Feet or Yards, ording as the Diameter was measured Inches, *&c.*

But with more expedition by the Instrunt, Thus,

Set 1 (a Diameter) upon the Line D, 785398 (the Area thereof) upon C.

This done, the Lines are like a Table of rcles Area to all Diameters, for against Diameter upon the Line D, you have Area thereof upon C.

Example: *Let the Diameter be 20.*

Set 1 upon D, to .785398 upon C, and en against 20 upon D, is 314.159 the ea required upon C, and as the Rule w stands I also find that when

the

$$\text{the Diameter is}\left\{\begin{matrix}25\\30\\40\end{matrix}\right\}\text{the Area will be}\left\{\begin{matrix}490.87\\706.85\\1256.63\end{matrix}\right\}\text{Ind}$$

Contrariwise when the

$$\text{Area is}\left\{\begin{matrix}300\\400\\500\end{matrix}\right\}\text{the Diam. will be}\left\{\begin{matrix}19.54\\22.56\\25.23\end{matrix}\right\}$$

2. *For the Area in Gallons or Barrels,*

The Area in Inches Divided by 282 231, Quote the Area in Ale or Wine G lons respectively, and so for any ot measure expressed in the former Tabl but without knowiug the Area in Inch the Area in Gallons or Barrels may be fo thus: Divide .785398

$$\text{By}\left\{\begin{matrix}282\\231\\9024\\10512\end{matrix}\right\}\text{the Quot. is}\left\{\begin{matrix}.0027851\\.0033999\\.00008703\\.00007471\end{matrix}\right\}\begin{matrix}\text{A G}\\\text{W G}\\\text{A B}\\\text{B B}\end{matrix}$$

The ſeveral Quotients are the Area of a ...cle whoſe Diameter is 1, in Ale or Wine ...llons, Ale or Beer Barrels reſpectively, ... are fixed Multiplicators for finding the ...a of all Circles in any of the meaſures ...ve named, for *As* 1 is to any of thoſe ...mbers, *So* is the Square of any Diame... to the Area in Ale or Wine, *&c.* re...ctively.

...f you would effect this by Diviſion, the ...eral Diviſors are thus found, Multiply ...e Diviſor for finding the Area in Inches, ... 1.27324

By	282	the Prod. is	359.05	A G
	231		294.11	W G
	9024		11489.71	A B
	10152		12925.93	B B

These ſeveral Products are the Diviſors ...ght. And the Square of any Diameter ...vided by one of theſe quotes the re...ctive Area.

But the moſt eaſie and ready way is by ...e Inſtrument.

Example.

Suppoſe the Diameter of a Circle be 40 In...es, How many Ale or Wine Gallons, Beer ... Ale Barrels will this contain at 1 Inch deep?

First

First for Ale Gallons.

Set 1 (a Diameter) upon D, to (the A[rea] thereof in Ale Gallons, *viz.*) .0027851 up[on] C, this done the Lines are like a Table shew[ing] the Area's of all Circles in Ale Gallons, [for] against any Diameter upon D, you have [the] Area upon C, as against 40 (the Diam[eter] proposed) you have 4.456, and with[out] moving the Rule I likewise find that w[hen] the Diameter

Is	45 50 52.5 58.6	the Area will be	5.639 6.962 7.676 9.563	A G.

Also against any Area upon C, you ha[ve] the Diameter upon D, as suppose the Ar[ea] were 1 Gallon, against 1 at the beginni[ng] of the Line C, you have 18.95 (at AG) which is call'd the Gage-point, it being t[he] Diameter of a Circle whose Area is 282 the Number of Inches in an Ale Gallo[n] and this Gage-point we shall hereafter ma[ke] use of in finding the Area, for by this E[x]ample it is evident, that to set 1 (an Are[a]) upon C, to the Diameter thereof, or Gag[e-]

poin[t]

nt, *viz.*) 18.95 upon D, is the same g, as 'tis to set 1 (a Diameter) upon to (the Area thereof, *viz.*) .0027851 n C, for in doing the one you also effect other.

What hath been said of finding the Area Ale Gallons, may be understood of the ine Gallons, and also of Ale or Beer rrels. For the Area in Wine Gallons: 1 upon D, to (the Area thereof in Wine llons, *viz.*) .003399 upon C, or (which ll one) set 1 upon C to (the Diameter Gage-point, *viz.*) 17.15 upon D, this e against any Diameter upon D, you e the Area in Wine Gallons upon C, against 40, is 5.44, against 52.5 you e 9.37, and so for any other.

3. *For the Area in Ale-Barrels.*

Set 1 upon D, to (the Area in Ale Barrels, .) .00008703 upon C: Or,

Set 1 upon C, to the Gage-point for an e Barrel, *viz.*) 107.19 upon D.

Then against any Diameter upon D, u have the Area upon C: So against 40, ind .139 of an Ale Barrel, in like manner the Diameter were 151.6, the Area is Barrels, the like may be done for Beer Barrels,

Barrels, for which the Gage-point is at
But to make this as plain as is poss
Note, When the Area of any Circle is fo
in Ale or Wine Gallons, if the Diam
be more than 17.15 (the Gauge-poin
Wine) or 18.95 the Gauge-point for
Gallons) yet less than 100, in such a
set the Gauge-point upon D, to 1 a
beginning of C, then against any Dia
from the Gauge-point to 100 upon D,
have the Area upon C in Ale or Wine G
according to the Gauge-point made us
Thus the Rule being set for Ale, you
find that when the

Diam. is	30	the Area will be	2.507	Gal
	40		4.456	
	60		10.029	
	80		17.825	
	100		27.851	

When the Diameter is less than
Gauge-point or more than 100,
set the Gauge-point to 1 in the middle u
C, this done against these

Diameters upon D	15	you have these Area's upon C	.627	A. G
	13		.471	
	10		.278	

d without moving the Rule, if 10 at
beginning of D be 100, the Area a-
it will be 27.851: So againſt this
eter, *viz.* 200, the Area is 111.4 Gall.
ſt 300, it is 250.7, and ſo on to 600
s Diameter, againſt which you have
.9, *&c.* by this you may further ob-
, that if the Diameter be increaſed by
, the Area will increaſe by hundreds:
,

he	10	gives	.2782	Gallon.
meter	100		27.82	
	60		10.029	
	600		100.29	

The like for Wine Gallons.

Laſtly.

ind any part of the Area of a Circle in Ale or Wine Gallons, &c.

t the Gauge-point to $\frac{1}{3}$, $\frac{1}{2}$ or any other
of 1; then againſt the Diameter you
the like part of the Area.

mple: *Let it be required to find the third rt of the Area of a Circle in Ale Gallons.*

et the Gauge-point to $\frac{1}{3}$ of 1, *viz.* .333,
againſt any Diameter you have $\frac{1}{3}$ of
the

the Area, thus against 100 is 9.273, is $\frac{1}{3}$ of 27.82, the whole Area.

Understand the like for Wine Gal Ale or Beer Barrels.

Probl. III.

The two Cross Diameters of an Ellipsis given to find the Area or Content.

AS the Square of the Diameter Circle, is to the Area of that C So is the Rect-angle or Product of gr and lesser Diameters of an Ellipsis to Area thereof. Therefore Multiply greater Diameter by the lesser Diame then that Product Multiplied or Divi by the fixed Multiplicators or Divi given (in pages 66 and 67,) gives Area in Inches, Gallons or Barrels, ac ding to the Number made use of:

Or rather thus, (by the 11 Probl. of third Chapt.) find a Geometrical mean portion between the greater and lesser ameters, for this mean is the Diamete a Circle whose Area is equal to the A of the Ellipsis

Examp

Example.

Let the greater Diameter (c d, in Fig. 2.) [be] 72 Inches, and the lesser (e f) 50, by [th]e Rule above-cited, the Geometrical will [be] 60, the Diameter of a Circle equal to [th]e Ellipsis.

Therefore;

Set the Gauge-point (A g) to 1 upon C, [th]en against 60 upon D, is 10.02 the Area of [th]e Ellipsis in Ale Gallons at one Inch deep: [T]he like may be done for Wine Gallons, [A]le or Beer Barrels.

Probl. IV.

[T]o find the Area or Content of a Triangular Superficies.

IN all Right-lined Triangles, Multiply half the longest side (or Base) by the [Pe]rpendicular (which is always the nearest [D]istance from the Base to the opposite An[g]le;) or Multiply half the Perpendicular [b]y the whole Base; this done, the Product [is] the Area required.

Example.

Let Fig. 3. represent a Triangular B
or Cooler, and suppose with this or so
other Instrument, I measure the long
side a b, and find 260 Inches, I t
set the end of my Cane in the oppo
Angle, (*viz.*) c, and drawing out the R
I move it to and fro by the side a b,
I find the shortest distance, which will
the Line c o, 110 Inches, this Multip
by 130 (the half of a b,) the Produ
14300, the Area in Square Inches, w
divided by 282 quotes 50.7, the Are
Ale Gallons at one Inch deep.

But the Area in Gallons may be found
the Instrument at one operation, with
knowing the Area in Inches: Thus,
282 upon B, to 110 (the Perpendicu
upon A, then against 130 (the half Ba
upon B, is 50.7 the Area as before: O
Set 282 upon A, to 260 (the whole B
upon B, then against half the Perpe
cular, *viz.* 55 upon A, is 50.7 as bef

To measure Quadrangular Figure.

Probl. V.

In any Right-angled Parallelogram be it Square or Oblong: The Product of any two sides including one and the same Angle, is equal to the Area or Content.

Example 1.

IN Fig. 5. (being Square) the sides h i and i k are equal, suppose each be 130 Inches; this Multiplied by it self is 16900 the Area in Square Inches: For the Area in Gallons by the Rule:

Set 282 upon B, to 130 upon A, then against 130 upon B, is 59.9 the Area in Ale Gallons at one Inch deep.

Example 2.

Of an Oblong (Fig. 4.)

Suppose n s 130 Inches, and s u 180, the Prodnct of these (being Multiplied) is 23400 the Area in Inches: But for Ale Gall. Set 282 upon B, to 180 upon A, then against 130 upon B, is 82.9 Ale Gallons the Area required.

Probl. VI.

In any oblique Angled Parallelogram (bei[ng a] Rhombus or a Rhomboides) Multiply [the] shortest distance between the two longest [sides] by one of the said sides, the Product is [the] Area.

Example 1.

Of a Rhombus (Fig. 7.)

Suppose the side p t were 130 Inch[es] and the distance q y 108, these Mult[i]plied the Product will be 14040 the Ar[ea] in Inches: But by the Rule thus,

As 282 is to 108, *So* is 130 to 49.[…] the Area in Ale Gallons at one Inch deep.

Example 2.

Of a Rhomboides (Fig. 6.)

Let the side x z be 260, and the distan[ce] t w 108, the Product of these is 280[…] the Area in Inches. By the Rule:

Set 282 upon A, to 260 upon B, th[en] against 108 upon A, is 99.57 the Area [in] Ale Gallons.

Probl.

Probl. VII.

In any Trapezium a Line drawn from one of the Acute Angles to the Angle opposite will divide the Trapezium into two Triangles, the Area's of which are equal to the Area of the whole Trapezium, and may be found by the 4. Probl. *of this* Chap. Or thus, *Multiply the sum of the two Perpendiculars by half the distance between the two Acute Angles, (it being the common Base to each Triangle) this done the Product is the Area of the Trapezium.*

Example.

Fig. 8. being a Trapezium is divided into two Triangles by the prick Line a b, which is a common Base to each Triangle: suppose it 260 Inches, then to the Perpendicular s e 110 add the Perpendicular 60, the sum is 170, this Multiplied by half a b, *viz.* 130, the Product will be 22100 the Area in Inches, but for the Area in Gallons.

Set 282 upon A, to 170 upon B, then against 130 upon A, is 78.3 the Area in Ale Gallons: And as the Trapezium, so all

all other irregular (Right-lined) Figur
consisting of more than four sides, must
divided into Triangles (which will ever
less by 2 than the Number of sides) a
then the Areas of those Triangles are eq
to the Area of the whole Figure.

Probl. VIII.

*The sides of any Regular Polygon being gi
to find the Area.*

IN any Regular Polygon, Multiply half t
Sum of the sides by the Perpendicu
(or nearest distance from the Center to
of the sides) this done the Product is t
Area.

Example, in a Pentagon (or Figure
five equal sides;) as Fig. 9.

Suppose each side be one Inch, to find
Perpendicular (CA) we have given AB=
and the Angle at C = 36 *d.*

Therefore,

		Log.
As the *sine* C = 36 *d.*	*Co. Ar.*	0.2307
Is to the side AB = .5		0.6989
So is the *sine* B = 54 *d.*		9.9079
To the side CA = .68819		.8377

whi

...ch is the Perpendicular sought, and ... .68819 Multiplied by half the sum of ... sides, *viz*. 2.5, the Product is 1.7204, the ...a of a Pentagon whose side is 1 Inch; ... by this method I find the Area of all ... other Polygons sides which are ex-...st in the following Table. In the first ...umn of which you have the names of the ...ygons, in the second their Areas in Inches, ...h of which being divided by 282 Quotes ... Area in Ale Gallons, which are the Num-... in the third Column.

Names of Polygons.	*Area's in Inches.*	*Area's in Ale-gallons.*
Pentagon	1.27047	.006101
Hexagon	2.59809	.009212
Heptagon	3.63440	.012888
Octagon	4.82840	.017120
Nonogon	6.18210	.021920
Decagon	7.69400	.027280
Undecagon	9.36760	.033210
Dodecagon	11.1960	.039700

Now having the Area (both in Inches ... Ale Gallons) of these Polygons when ... side is Unity, the Area of each may be ...dily found when the side is any known ...gth: For,

As the Square of the side of any Poly-
gon is to the Area of that Polygon,

So is the Square of the side of any other
like Polygon to the Area thereof:

Therefore,

If the Area of any Polygon (express'd
in the Table) be desired.

Multiply the Square of the side by a Num-
ber in the second Column against the name
of the Polygon given, this done, the Pro-
duct will be the Area in Square Inches,
Feet or Yards, according as the side was
given in Inches, Feet or Yards.

And if the Square of the side taken in In-
ches be Multiplied by a Number in the third
Column, the Product is the Area in
Gallons.

Example.

Suppose the side of a Pentagon be 50
Inches, this Squared is 2500 which Mul-
tiplied by the first Number in the second
Column, (*viz.*) 1.72047, the Product will
be 4301.175, the Area in Square Inches.

And if the Square of 50 (*viz.*) 2500
Multiplied by the first Number in the third
Column, *viz.* .006101, the Product

15.252 the Area in Ale Gallons, which ees exactly with the former, for if you ide the Area in Inches, *viz.* 4301.175 282, the Quotient will be 15.252.

This may be easily performed by the ftrument, for there you have the Square any Number by Inspection, and the Mul- plication is quickly wrought by the Lines and B.

But the Lines C and D, will effect the hole with much more expedition, for at ce setting of the Rule you have the ea (in Inches or Ale Gallons) to any en side, or the side to any Area given.

Example.

First for the Area in Inches, Suppose as fore the side of a Pentagon be 50, *What the Area?*

Set 1 upon D to (the Area when the de is 1, *viz.*) 1.72047 upon C, then ainst 50 the side given upon D, is 301.175 the Area in Square Inches, and the Rule now stands, against any side iven upon D, you have the Area upon C, us against 55 a side given upon D, is 5204 the Area: So likewise when the de be 47, the Area will be 3800.5 In Con- rariwise;

 Against

Against any Area upon C you have th side upon D: So if the Area of a Pentago were 3000, the side will be 41.75, &c.

Secondly, For the Area in Ale Gallons Set 1 upon D to (the Area in Gallons wh the side is 1, *viz.*) .006101 upon C, th done, against any side upon D you hav the Area upon C, and the contrary.

Thus against 50 upon D, is 15.25 the Area in Ale Gallons: Also against 1 Gallons an Area upon C, you have 60 th side upon D, &c.

It's needless to give Examples of th other Polygons, for what hath been sai of the Pentagon may be understood of th other Polygons, remembring to use th proper Numbers as aforesaid.

CHAP. VI.

The use of the Rule in the mensuratio of Solids, and first of a Prism.

A *Prism* is a Solid contained by severa Planes, two of which being opposit are call'd the Bases, and these are equal Parallel, alike and alike situate, but th

othe

er Planes are Parallelograms, in which a ght-line may be every where applied m Base to Base: Under this name *Prism* comprehended that Solid of two Circular es, usually called a Cylinder.

Probl. I.

To find the Solid Content of a Prism.

Multiply the Area of the Base by the Perpendicular height, this done the duct is the Content sought.

Example.

Let (Fig. 11.) represent a Brewers Tun he form of a Square Prism, whose Base ,k,i, is equal to Fig. 5. each side being Inches, and the Perpendicular (s i) 30 hes, how many Ale Gall. or Beer Bar- s will this Tun contain?

By the first Example in page 75 the Area the Base or Content at one Inch deep s found to be 59.9 Ale Gallons.

Therefore,

Set 1 upon B to 30 (the depth upon A, n against 59.9 (the Area) upon B, is

1797

1797 the Content in Ale Gallons, this [di]vided by 36 quotes 49.916, the Con[tent] in Beer Barrels.

Or Thus,

For the Content in Beer Barrels without k[now]ing the Content in Ale Gallons.

Set 10152 (the Inches in a Barrel) up[on] B, to 130 upon A, then against 130 up[on] B, is 1.6639 the Area in Beer Barrels at [an] Inch deep. Which Multiplied by 30 [the] whole depth gives 49.916, the Conte[nt as] before.

The Fraction .916 (being reduced) [is] 33 Gallons, For,

As 1.000 . 36 :: .916 . 33.

So the Content of the Tun is 49 Bar[rels] 3 Firkins and six Gallons.

Example 2.

Of a Round Prism or Cylinder.

Let Fig. 12. Represent a round T[un] whose Diameter (n o) at top is equal to (v) the Diameter at bottom, each being [..] Inches, and the Altitude e x 36 Inch[es]

Ho[w]

w many Ale Gallons or Beer Barrels y this Tun contain? First for Gall.

et the Gauge-point a g, to 1 upon C, n against 120 the Diameter upon D, 40.1 the Content in Gallons at one Inch p, this Multiplied by 36 the whole pth, the Product is 1443.6 the whole ntent.

Or thus at one Operation.

Set the Gauge-point to 36 the Tuns pth upon C, then against 120 the Dieter upon D, is 1443.6 the Content as fore.

2. For the Content in Beer Barrels 1443.6 vided by 36, quotes 40.1 the Content in rrels.

Or rather thus.

Set the Gauge-point for a Beer Barrel, viz.) B b to 36 the depth upon C, then ainst 120 upon D, is 40.1 the Content s before.

ow suppose I come to this Tun and find the Liquor 9 Inches deep, How many Bear Barrels are then contained in the Tun?

Set

Set the Gauge-point (B, b) to 9, t against 120 is 10.02, that is, 10 Barr and 1 Gallon *ferè*, the quantity of Liq sought.

Probl. II.

The Diameter and depth in Inches, and Content in Beer Barrels of any Cylindri Tun, any two being given the third may found.

IN this Problem are Three Question but all resolved at once setting the Ru

1. By the depth and Content to find t Diameter.

Example.

Suppose the depth 40 Inches, and the Conte 50 Beer Barrels, What is the Diameter?

Set 40 the depth upon C, to the Gauge point B b, upon D: Then against 50 th Content upon C is 127.1 Inches, the Di ameter sought.

2. By the Diameter and Content to fin the depth, without moving the Rule Say,

As 127.1 the Diameter
is to 50 the Content
is the Gauge-point Bb
to 40 the depth

upon D, C, D, C

By the Depth and Diameter to find
Content, the Rule standing as before:

As the Gauge-point Bb
is to 40 the depth
is 127.1 the Diameter
to 50 the Content

upon D, C, D, C

Note, As a Circle is the Base of a Cy-
[illegible]er or round Prism, so a Triangle,
[illegible]drangle, or any other plain Superficies
[illegible] represent the Base of a Solid, for if
[illegible]r be Planes erected perpendicularly upon
[illegible] Line or Lines, which incompass any
[illegible] Superficies, they will generate a So-
[illegible] which may be called a Prism, and the
[illegible]tent of any such Solid is gotten by Mul-
[illegible]ying the Area of the Base by the Altitude
[illegible] distance from one Base to another.

Probl: III.

Probl. III.

The Diameter of a Sphere or Globe being giv[en in] Inches, to find the Content thereof in In[ches] or Gallons both Ale and Wine.

A Sphere is two third parts of a Cy[lin]der, whose Diameter and Altit[ude] are equal to the Diameter of the Sphere.

But if the Diameter and Altitude [of a] Cylinder be 1, the Area of the Base (w[hich] is also the Solid Content (for 1 doth [not] Multiply) is .785398: Therefore [⅔ of] .785398, viz. .523598 is the Conten[t of] a Sphere whose Diameter is Unity or [1].

Moreover, all Bodies are in propor[tion] one to another as the Cube of their [like] sides:

Therefore,

As the Cube of the Diameter of a Sph[ere] is to the Content of that Sphere,

So is the Cube of the Diameter of [an]other Sphere to the Content thereof.

Now if the Diameter be 1, the C[ube] thereof is but 1.

Theref[ore]

Therefore,

s 1 is to .523598:
the Cube of the Diameter of any
Sphere to the Content.

Example,

the Diameter of a Sphere be 20 Inches
d the Content required in Solid Inches.

y the Lines D and C on the Rule, the
e of 20 will appear to be 8000, this
ltiplied by .523598, is 4188.78 the
ntent sought.

For the Content in Gallons.

If .523598 be divided

282 231	quotes	.001856 .002266	the content in	A.G. W.G.

Now if the Cube of the Diameter of
y Sphere be Multiplied by either of these
mbers, the Product will be the Content
Ale or Wine Gallons respectively: Thus,
he Cube of 20 the Diameter (*viz.*) 8000
ultiplied by .001856 is 14.848 the Con-
nt in Ale Gallons, and the like may be
one for Wine.

If

If you would effect this, by Divi[...] you may find the proper Divisors, [...] shown in page 64.

But the Content of any Sphere may [...] more readily found by the Instrument.

Thus,

Set 1 upon D, to .523598 upon E, [...] against any Diameter upon D, is the Con-tent upon E: So against 20 (the Diame[ter] above-mentioned) upon D, is 4188.78 [...] Content in Inches as before: In like man-ner if the Diameter were 30, the Con[tent] will be 14137.14, &c.

For Ale Gallons thus,

Set 1 upon D, to .001856 upon E, [...] against any Diameter upon D, is the Con-tent upon E, as against 20 upon D is 14[...] the Content as before, and without mov[ing] the Rule I find that if the

Diame- ter be	30	the con- tent is	50.13	A. G.
	40		118.78	

Contrariwise, if the Content be give[n] the Diameter may be found, for the Ru[le] being set as before, it will appear that,

...*s* against any Diameter upon D, you ...the Content upon E.
...against any Content upon E, you have ...iameter upon D.

Thus,

...inst	14.84 50.13 118.78	the Content is	20 30 40	the Diameter.

...he like may be done for Inches, or ...e Gallons.

Probl. IV.

...*ing the Altitude of the frustum of a Globe, ...gether with the Diameter of its Base, to ...d the Altitude of the other frustum or ...which is all one) the remainder of the ...lobes Axis.*

The Rule is,

DIvide the Square of the Semidiameter of the frustums Base, by the Altitude ...either of the frustums, the Quotient ...l be the Altitude of the other frustum.

Example.

Example.

In Fig. 10. Let c b the Altitude of frustum be 6 Inches, and d c e the Diameter at the Base 24, the half of this (viz. d c) is 12, which Squared is 144, this divided by the Altitude b c, *viz.* 6, the Quotient is 24 equal to c a, the Altitude of the other frustum. Note also, that a Geometrical mean proportion between a c and c b is equal to c d, which doubled is d e, the Diameter of the frustums Base.

Probl. V.

Having the Altitude of the greater and lesser frustums of a Globe, and the Diameter of the Base, to find the Content of the lesser frustum.

The Rule,

1. BY the Diameter at the frustums Base find the Area of a Circle equal thereto, which Multiply by the lesser frustums Altitude reserving the Product.

2.

To $\frac{1}{2}$ the Altitude of the greater [frust]um, add $\frac{1}{6}$ of the Altitude of the lesser, [a]lone, Multiply the Sum by the for[mer] Product, and divide this last Product [by th]e Altitude of the greater frustum, [the] Quotient will be the Content of the frustum sought.

Example.

Fig. 10. Let ca, the Altitude of the [great]er frustum, and dce the Diameter of [the f]rustums Base be each 24 Inches, cb [the A]ltitude of the lesser frustum 6 Inches, [wha]t is the Content of the lesser frustum [(d]c b) in Ale Gallons?

[T]he Area of a Circle whose Diameter is [equa]l de (*viz.* 24 Inches) is 1.6042, this [Mult]iplied by cb, 6, is 9.6252 which keep: [Aga]in, half ac is 12, to which add $\frac{1}{6}$ of [cb] *viz.* 1, the Sum is 13, this Multiplied [by 9].6252 is 125.127, and this divided [by] ac, *viz.* 24, the Quotient will be [5.21]3, the Content of the frustum in Ale [Gall]ons. But this may be perform'd with [grea]ter expedition by the Instrument.

Thus,

Thus,

1. Set 1 upon D to the frustum
tude, *viz*. 6, upon C, then against
ameter of the Base, *viz*. 24, is 9.625,
keep.

2. Set the Altitude of the greater
viz. 24, upon A, to 13 (that is $\frac{1}{3}$ a
$\frac{1}{6}$ of cb) upon B, then against
upon A is 5.2134, the Content as be

CHAP. VII.

The Use of the Instrument in Mensuration of Pyramids and Frustums.

A *Pyramid* is a Body contain'd
several Planes, set upon one
lined Base, and meeting in a po
the top which is called the Vertex
in each of these Planes a Right-lin
be every where applied from the
the Vertex.

And under this name *Pyramid* is
prehended that Pyramidical Body (
Base is a Circle) commonly called a C

Probl. I.

[To] find the Solid Content of a Pyramid.

[A] *Pyramid* is one third part of a *Prism*, which hath the same Base as the Py[rami]d, and the Altitude equal thereto:

Therefore,

[M]ultiply the Area of the Base by ⅓ of the [Altit]ude, or ⅓ of the Area by the whole [Altit]ude, in either cases the Product will [be t]he Content of the Pyramid.

Example 1.

[In] a Square Pyramid (as Fig. 17.) suppose [the S]ide of the Base x p be 112 Inches, and [the] Altitude (or Perpendicular) z s 90 Inch. [How] many Solid Inches, Ale Gallons, or [Beer] Barrels may this Pyramid contain?

For the Area of the Base.

[Sa]y $\left\{\begin{array}{l}\textit{As } 1\\ \textit{So} \text{ is } 112\end{array}\right\}$ upon B $\left\{\begin{array}{l}\text{is to } 112\\ \text{to } 12544\end{array}\right\}$ upon A.

The Area of the Base in Inches.

Again,

Again,

Set 1 upon B, $\frac{1}{3}$ part of the Alti
(*viz.* 30.) upon A, then against the
of the Base, *viz.* 12544 upon B, is 37
the Content in Solid Inches, which d
by 282 quotes 1334.46, the Content i
Gallons.

Or rather thus,

Set 282 } upon { to 112 }
then against 112 } B { is 44.48 }

the Area of the Base in Ale Gallons.
Set 1 upon A, to 30 upon B, and a
44.48 upon A is 1334.46 the Cont
Ale Gallons.

For the Content in Beer Barrels.

Set 10152 (the Inches in a Beer
rel) upon B to 112 upon A; then a
112 upon B is 1.2356, the Area of the
in Beer Barrels.

Again,

et 1	}	upon	{	to 30	} upon
against 1.235	}	B,	{	is 37.06	} A.

Content is 37 Barrels and 2½ Gall. *fere*.

Example 2.

There is a round Pyramid or Cone (as 18.) suppose the Diameter at the Base be 100 Inches, and the Altitude nx; How many Square Inches, Ale Gal- or Beer Barrels may this Cone Contain.

For the Content in Inches.

et 1.128 (the Diameter of a Circle ose Area is 1) upon D to ⅓ part of the itude (*viz.* 60.) upon C, then against (the Diameter) upon D, is 471238.8 Content in Inches, which divided by is 1671, the Content in Ale Gallons.

Or thus,

Set the Gauge-point for an Ale Gallon of the Altitude (*viz.* 60.) upon C:

F Then

Then against 100 upon D is 1671 the Co-tent as before.

For the Content in Barrels.

Set the Gauge-point for a Beer Ba- (*viz.* 113.69.) to 60 upon C, then agi- 100 upon D is 46.417 the Content fou- the Fraction is equal to 15 Gallons: F-

As 1 to 36: *So* is .417 to 15: So- whole Content is 46 Barrels, and 15 G-

Example 3.

Shall be of a Pentagonal Pyramid, tha- a Pyramid whose Base is a Pentagon- Figure of five equal sides: Suppose e- side be 30 Inches, and the Altitude - What is the Content in Inches or Ale G- lons?

If the side of a Pentagon be 1 Inch, - Area

$$\text{in} \left\{ \begin{array}{l} \text{Inches} \\ \text{Ale Gall.} \end{array} \right\} \text{is} \left\{ \begin{array}{l} 1.7204 \\ .006101 \end{array} \right\}$$

as appears by the Table in page 79.

Now to find the Content of the Py- mid abovesaid,

t 1 upon D to 1.7204 upon C; then
nst 30 (the side) upon D is 1548.423,
Content of the Base in Inches.

Again,

t 1 upon B to 15 ($\frac{1}{3}$ of the Altitude)
n A.
hen against 1548.423 upon B, is
26.34 the Content in Solid Inches,
divided by 282 is 82.36 the Content
allons.

Or thus,

t 1 upon D, to .006101 upon C; then
nst 30 upon D is 5.49 upon C: Again,
t 1 upon B to 15 upon A, then against
upon B is 82.36, the Content as be-
Thus for whole Pyramids.
The Frustum of a Pyramid is the lower
cut off with a Plain parallel to the
, the upper Part remaining is also a
amid.

Probl. II.

find the Solid Content of the Frustum of a Pyramid.

BY the Rules aforegoing, find the Area of the greater and also of the lesser
e.

2. Find a Geometrical mean proporti
betwixt the the two Area's abovesaid.

3. The sum of these three being Mu
tiplyed by ⅓ part of the Altitude, the Pr
duct is the Content sought.

Example.

Let *aceo* (in Fig. 18.) represent t
Frustum of a round Pyramid or Cone, w
the Diameter of the greater base is 1
Inches, *ce* the Diameter of the lesser b
81, and *nv* the Altitude 36 Inches, Ho
many Ale Gallons will this Frustum contai

1. Set the Gauge-point to 1 in the midd
of the Line C.

Then against 108 upon D is 32.48, t
Area of the greater base in Ale Gallons.

2. Set the Gauge-point to 1 at the b
ginning of the Line C.

Then against 81 upon D, is 18.27 t
Area of the lesser base.

3. Set 32.48 upon C, to 32.48 upon D

Then against 18.27 upon C, is 24.36 t
Geometrical mean betwixt the two Areas.

So the Area of the Greater Base is 32.4
The Area of the lesser is ——— 18.2
The Geometrical mean is ——— 24.3

The Sum of these, *viz.* ——— 75.1

ing Multiplied by ⅓ of the Altitude (*viz.*
.) the Product is 901.32, the Content
the Frustum sought.

A second way (which is also a proof of the former) may be thus:

Find the Content of the whole Cone *a x o*,
o the Content of the lesser Cone, cut off
e, then subtract the lesser from the
eater, the remainder is the Content of
e Frustum.

To find the Content of the whole Cone,
is requisite that we first find its Altitude,
d that may be done by this proportion.

As the Difference of the Diameter is
the greater of them:

So is the Altitude of the Frustum to the
the Altitude of the whole Cone.

In the last Example the Diameter of the
reater Base *a o*, is ———— 108
he Diameter of the lesser *c e* ——— 81

The difference is ———— 27

And the Frustums Altitude *n v* is 36.

Therefore,

Set the difference 27 upon B, to 108
pon A.

 Then

Then against 36 the Frustums Alti-
upon B, is 144 upon A, which is the Al-
tude of the whole Cone (*viz.* *nx*.)

Now for the Content.

The Area of the Base by the last is 32.
this Multiplied by $\frac{1}{3}$ of *nx*, *viz.* 48,
Product is 1559.04, the Content of
whole Cone.

In the lesser Cone *cex*, the Area of
Base ce (which is also the lesser Base of
Frustum) is 18.27, this Multiplied by
vx, (*viz.*) 36 gives 657.72, the Con-
of the lesser Cone; this subtracted from
Content of the whole, that is, 1559.
there will remain 901.32, the Content
the Frustum, which agrees exactly
former.

CHAP. VIII.

*Shewing the Use of the Rule in findi-
the whole Content of Tuns and Coppe-
and also in Inching the same.*

Tuns are of various forms and Figur-
but are vulgarly distinguish'd by th-

nominations, *viz.* Round, Elliptical or Sq. der each of which there are several varie- s both regular and irregular. But supposing eir sides to be without Curveture (that is, hen a Right-line may be every where ap- ied from one Base to the other) I shall re chiefly consider them with respect to eir Bases which I also suppose to be pa- llel.

I. *Of Round Tuns.*

1. When the Bases are both Round, if ey be also equal, the Tun is call'd a Cy- nder, (and may be Gauged as in page 85.)

2. If the Circular Bases be unequal, the un is call'd the Frustum of a Cone, (and e Content may be found as in page 99.)

II. *Of Elliptical Tuns.*

1. If the Bases are both Elliptical equal nd a like situate, the Tun may be call'd a rism, and Gauged as such. (See page 83.)

2. If the Elliptical Bases be alike situate ut unequal, they are either proportional r disproportional, when they are propor- ional, it will be:

As the Axis of the greater Base is to the Axis of the lesser:

So is the Conjugate of the greater Base to the Conjugate of the lesser.

And when it is thus, the Tun may be call'd the Frustum of an Elliptical Cone. [See Prob. 4. of this Chap.].

3. When the Elliptical Bases are disproportional, or if one Base be Elliptical and the other Circular, it may be call'd a Cylindroid. [See Prob. 5. Chap. 8.]

III. *Of Square Tuns.*

1. Those which are usually call'd Square Tuns, their Bases are Rect-angular Parallelograms, and these are either Square or Oblong.

2. When the Bases are both Square, if they be also equal, the Tun is a Prism; and Gauged as in page 83.

3. When the Square Bases are unequal, it is the Frustum of a Pyramid. [See Prob. 2. Chap. 8.]

4. When the Bases are both Oblong, if they be also equal, alike, and alike situate, the Tun is a Prism, and Gauged as such.

5. When

5. When the Oblong Bases are unequal, hey are either proportional or dispro-ortional, when they are proportional it ill be,

As the length of the greater Base is to he length of the lesser:

So is the breadth of the greater to the readth of the lesser.

And when it is thus, the Tun is the rustum of a Pyramid, and may be Gauged s such.

6. When the sides of the Oblong Bases re disproportional, or when one Base is Oblong, and the other Square, the Tun nay be call'd a Prismoid. See Probl. 5. f this Chap.

Note: There is the same Analogy be-twixt a Square and Oblong, as betwixt a Circle and Ellipsis, and also betwixt a Square and a Circle, as betwixt an Oblong nd Ellipsis: Therefore what is said in the ollowing Problems of any one of these will elate to the other also.

Probl. I.

There is a Tun call'd a Prism (as Fig. 11.) whereof the Bases are both exactly Square and equal, each side of either Base being 84 Inches, and the depth 33, What is the Tuns Content in Ale Gallons?

The Rule.

Multiply the Square of the side by the depth, the Product is the Content in Square Inches, which divided by 282, gives the Content in Ale Gallons.

Example.

By the Lines C and D on the Rule, the Square of the side 84 is 7056, this Multiplied by 33 (the depth) is 232848 the Content in Square Inches, and this divided by 282 gives 825.7, the Content in Ale Gallons required.

Note: A Square to a Circle inscribed in it is as 14 to 11, or nearer as 1 to .785398: Therefore having found the Content of the Square Tun, *viz.* 825.7: Say,

As

As 1 to .785398, So is 825.7 the Content of the Square Tun, to 648.51 the Content of a Round Tun whose Diameter is 84 Inches, and depth 33, For,

As the Content of any Square, is to the Content of a Circle inscribed in it:

So is the Content of a Square Tun, to the Content of a Round Tun inscribed in it.

Note: Further, that the Square of the Diameter of any Circle divided by 359.05, gives the Content in Ale Gallons.

Therefore,

The Content of any Square Tun in Inches divided by 359.05, gives the Content in Ale Gallons.

So in the Example above, if 232848 the Content in Inches, be divided by 359.05, the Quotient is 648.51, the Content as before.

Moreover,

If it were a Round Tun of the same depth and Diameter. Set the Gauge-point for an Ale Gallon to 1, then against 84 the Diameter, is 19.652 the Area; this Multiplied by 33, the depth, is 684.51, the Content of the Round Tun in Ale Gallons. Now,

As

As 11 to 14, or as .785398 to 1,
So is 684.51 to 825.7, the Content of the Square Tun as before.

Probl. II.

There is a Tun (as Fig. 17.) whose Bases are both perfectly Square but unequal, the side at the bottom x p = 108 *Inches, the side at the top* o r, 93, *and the depth* s a 30 *Inches, What is the Content in Ale Gallons?*

THis Tun being the Frustum of a Pyramid may be Gauged by the Rule given in page 99.

Or, thus:

1. Square the side of the greater Base, and also the side of the lesser Base.

2. Multiply the greater side by the lesser, and to the Product add the two former Squares.

3. The Sum of these three being Multiplied by $\frac{1}{3}$ of the depth, gives the Content in Square Inches, which divided by 282 the Quotient is the Content in Ale Gallons.

Example.

Example.

By the Instrument the Square of $x\ p$ is ———————— 11664

The Square of $o\ r$ 93, is ———— 8649

108 Multiplied by 93, is ———— 10044

Sum is ————	30357
Multiplied by $\frac{1}{3}$ Altitude ————	10
The Product, *viz.* ————	303570

Divided by 282 is 1076.48 the Content sought: Then,

As 1 to .785398 : *So* is 1076.48 to 845.6 the Content of a Conical Tun, whose Diameters at top and bottom are equal to the sides of the former Square Tun, and the depth the same: Or if the last Product, *viz.* 303570 be divided by 359.05, the Quotient will be 845.6, the Content of the Conical Tun as before.

Note: If the Bases of the Tun aforegoing, were any of the Regular Polygons, like and alike situate, proceed with the sides as in the last Example, only remember to Multiply the last Product by a number proper for the Polygon given, which number find in the Table for that purpose, page 79. So if each Base of a Tun were a

a Pentagon (or Figure of Five equal sides) suppose the side at top and bottom, and also the depth the same as in the last Square Tun: If you proceed according to the Rule there given, the last Product will be 3035... this Multiplied by .006101, the Tabular number for a Pentagon, the Product will be 1852.08, the Content in Ale Gallons sought; and so for any Polygon in the said Table mentioned.

Probl. III.

A more quick and practical way for finding the Content of any Conical Tun by the Instrument.

The Rule is,

SUbtract the Diameter of the lesser Base from the Diameter of the greater, and add half the difference to the lesser, the Sum is the Diameter in the middle of the Tuns depth; which found,

1. Set the Gauge-point (a. g.) to the Tuns depth upon C.

Then against the Diameter (found as above) upon D, is a fourth number upon C, which keep.

2. Set

. Set the Gauge-point to $\frac{1}{3}$ of the Tuns
th upon C.

Then against $\frac{1}{2}$ the difference of the Di-
ters upon D, is a fourth number, which
ed to the fourth number first found, is
Content of the Tun sought.

Example.

Let *aoec* (in Fig. 18.) represent a Coni-
Tun, *ao* the Diameter of the greater
e 108 Inches, *ec* the Diameter of the
er Base 81, and *un* the depth 36 Inch.
hat is the Content in Ale Gallons? The
ference of the Diameters is 27, the half
13.5, this added to 81, is 94.5 the Di-
eter in the middle of the Tuns depth.
ow,

1. Set the Gauge-point to 36 the Tuns
pth, then against 94.5, the Diameter is
5.3 which keep.

2. Set the Gauge-point to $\frac{1}{3}$ of the Tuns
pth, that is 12.

Then against 13.5 the semidifference of
e Diameters, is 6.06, this added to 895.3
he number first found) the sum is 901.36
e Content sought.

Probl.

Probl. IV.

There is a Tun (as Fig. 16.) whose Bases both oblong, unequal, but alike situate, the sides proportional, da *the length at bottom is* 100 *Inches, and* dc *the breadth* 80, he *the length at the top* 85, *and the breadth* 68, *and the depth* 30 *Inches. What is the Content in Ale Gallons?*

(AS *da* to *dc*, So is *he*, to *hg*: Therefore the sides are proportional.) The Content of this or any such like Tun may be found by the Rule given in the second Probl. of the VII. Chap.

Or thus,

1. Multiply *da* 100, by *dc* 80, Product is ———— 8000
2. Multiply *he* 85, by *hg* 68, Product is ———— 5780
3. A Geometrical mean betwixt these two is ———— 6800

Sum is ———— 20580

This Multiplied by $\frac{1}{3}$ of the depth, the Product is 205800, the Content in Square Inches,

ches, which divided by 282 gives 729.78, the Content in Ale Gallons.

Now suppose there be a Tun Elliptical both at top and bottom, let the Axis and Conjugates at each Base be equal to the lengths and breadths of the Tun above mention'd, and the depth the same: I say the Content of such an Elliptical Tun is 573.17 Ale Gallons: For,

As 1 *to* .785398: *So* is 729.78 (the Content of the Tun above found) *to* 573.17, the Content of the Elliptical Tun inscribed in it: Or if the last Product above, *viz.* 205800 be divided by 359.05, the Product will be 573.17, the Content of the Elliptical Tun as before.

Probl. V.

Let Fig. 16. *represent a Tun call'd a Prismoid, the Bases are Rect-angular Parallelograms unequal and disproportional, but parallel and alike situate;* a d *the length below* = 150 *Inches, and* a b *the breadth* 100, e h *the length above* 90, *and* e f *the breadth* 70, *and the depth* 30: *What is the Content in Ale Gallons?*

The

The Rule.

1. To the greater length *a d* add ½ the lesser length *e h*, and Multiply the sum by the greater breadth *a b*, reserving that Product.

2. To the lesser length *e h*, add ½ the greater length *a d*, and Multiply the sum by the lesser breadth *e f*; add this Product to the former reserved Product.

3. Multiply the sum of these two Products by ⅓ of the Tuns depth, and divide the last Product by 282, the Quotient will be the Content of the Tun in Ale Gallons.

Example.

1. *a d* 150 added to ½ *e h* 45, the sum is 195, this Multiplied by *a b* 100, the Product is 19500 which keep.

2. *e h* 90 added to ½ *a d* 75 the sum is 165, this Multiplied by *e f* 70, the Product is 11550, this added to the former Product, *viz.* 19500 the sum is 31050, this Multiplied by ⅓ of the depth, *viz.* 10, the Product is 310500 the Content in Square Inches, which divided by 282 gives the Content in Ale Gallons, *viz.* 1101.06: Then,

As

As 1 *to* .785398 : *So is* 1101.06 *to* 864.78 the Content of an Elliptical Tun or Cylindroid, whose Axis and Diameters are equal to the lengths and breadths of the former Prismoid:

Or, if you divide by 359.05 instead of 282, the Quotient will be 864.78 the Content of the Cylindroid as before.

In this last Problem the sides being disproportional, the Content cannot be found by the Rules given in the Problems aforegoing:

But the Content of any Tun whose Bases are Rect-angular Parallelograms and Parallel, whether they be equal and proportional, or unequal and disproportional, like situate or inverted, I say the Content of any such Tun may be found by the Rule given in this last Problem. And the truth of this Rule will plainly appear if you duly consider Fig. 13. in which *abcd* is equal to the greater Base, and *efgh* equal to the lesser Base of the Tun in the last Problem, (which was represented by Fig. 16.)

In this Fig. 13. *biov* is made equal to *fehg*.

Also,

Alſo, *ab* 100 leſs by *ef* 70, is equal to *ai* 30.

And *ad* 150 leſs *eh* 90, is equal to 60, the Altitude is 30 as before.

The Lines being drawn, the whole Solid is Compoſed of theſe parts, *viz.* three Priſms and a Pyramid.

The	1	Priſm is	*biouſehg*	
	2		*iasohe*	
	3		*ovcnhg*	

The Pyramid is *osndh.*

The Content of theſe four Solids being added together, gives the Content of the whole Solid *abcdefgh*; for the whole is equal to all its parts taken together. (Axiom 19. 1. *Euclid.*)

And the Content of theſe may be found thus:

1. Multiply *fg* 90 by *fe* 70, the Product is 6300; this Multiplied by *hf* the Altitude, *viz.* 30, gives 189000 the Content of the Priſm, *biovfehg.*

2. Mul-

2. Multiply *ai* 30 by *as* 90, the Product 2700, this Multiplied by ½ the Altitude, 15, is 40500 the Content of the Prism *iobe*.

3. Multiply *en* 70 by *no* 60, the Product is 4200; this Multiplied by 15 is 63000, the Content of the Prism *ovcnhg*.

4. Multiply *sd* 60 by *so* 30, the Product is 1800, this Multiplied by ⅓ of the Altitude, *viz.* 10, gives 18000 the Content of the Pyramid *sondh*.

So the Content of the	1	Prism is	189000
	2		40500
	3		63000
Pyramid is			18000
The Sum			310500

the Content in Square Inches, and is exactly the same with the Content found by the Rule given in the last Problem.

Note, In Problem 4th. aforegoing, there is mention made of a Tun whose Bases (being Rect-angular Parallelograms) are said to be alike situate, that is, the length above is directly opposite to the length below: Thus in Fig. 16. *eh* the length above is opposite to *ad* the length below, they being both in the same Plane.

The

The Content of this Tun was there fo[und] to be 729.78 Ale Gallons: Now let [the] bases of the same Tun be so situate, [that] the length above may be opposite to [the] breadth below: Thus in Fig. 15. *bg* [the] length above is opposite to *dc* the bre[adth] below, they being both in one and the s[ame] Plaine: In this case the Tun will con[tain] 735.81 Ale Gallons, as will appear by [the] work, which is by the Rule given in [the] 5th. Problem.

Thus *bg* 68 more by $\frac{1}{2}$ *da* 50 is 11[8,] this Multiplied by *be* 85 the Product [is] 10030.

Again *da* 100 more by $\frac{1}{2}$ *bg* 34 is 13[4,] this Multiplied by *dc* 80, the Product [is] 10720, the Sum of these two Products [is] 20750, which Multiplied by $\frac{1}{3}$ of the [Al]titude, *viz.* 10, gives 207500, the Con[tent] in Square Inches, this divided by 282 [the] Quotient is 735.81 the Content in Ale G[allons,] or if you divide by 359.05, the Quotie[nt] will be 577.91 the Content of an Ellipt[ical] Tun, whose Axis above is directly oppo[site] to the shorter Diameter below: It is ne[ed]less to give more Examples of this ca[se,] for it doth not often occur in practice.

Prob.

Probl. VI.

Fig. 14. *represent a Tun whose base be-* w abcd *is exactly Square, each side being* oo *Inches, but the bases above, viz.* hgfe *oblong,* ef *being* 74 *and* fg 100, *ppose the depth be* 30; *What is the Content Ale Gallons.*

MAke *di* and *ak* equal to *ef*, then will *ic* equal to *kb* be 26, this e, if you Multiply *di* 74 by *da* 100, Product is 7400, which Multiplied by the depth gives 222000, the Content he Prism *diakaefgh*.

Again,

Multiply *ic* 26 by *cb* 100, and the Pro- t, *viz.* 2600, by ½ the depth, that is the last Product is 39000 the Content he portion *icbkfg*.

Now most evident it is by the constru- on of the Figure, that the first Content, . 222000 being added to the Content found, *viz.* 39000, the sum is the Con- t of the whole Tun in Square Inches, . 261000, this divided by 282 gives 929.53

929.53 the Content in Ale Gallons: Or Content may be found by the Rule given in the last Problem:

Thus,

eb 100 more ½ *da* 50 is 150, this Multiplied by *ef* 74 gives 11100.

Again,

da 100 more ½ *eb* 50 is 150, this Multiplied by *dc* 100 gives 15000, which added to the former Product, *viz.* 11100, the sum is 261000 the Content in Inches, this divided by 282 gives 925.53, the Content in Ale Gallons as before.

Now suppose there be a Tun Circular below, and Elliptical above, let the Diameter of the Circular Base be equal to *ad*, and the Axis of the Elliptical Base equal to *eb*, each 100 Inches, let the shorter Diameter of the Elliptical Base be equal *ef* 74, and the depth 30 as before, I say the Content of this Elliptical Tun is 726.91 Ale Gallons: For,

As 1 *to* .785398: *So* is 925.53 *to* 726.91, or if you divide the Content of the first (in Inches,) *viz.* 261000, by 359.05 the Quotient will be 726.91 the Content of the Elliptical Tun as before.

By what hath been already ſaid I pre-
me it will not be difficult to find the whole
ontent of any Tun, whoſe ſides are ſtrait
om top to bottom.

I might now give ſome Rules for Inch-
g of any of the Tuns above mentioned.

But foraſmuch as no Tuns, but thoſe
hich are exactly regular (and very few
e ſo) can be Inched by Calculation, I
all therefore ſhew how it may be other-
iſe effected: And that is by taking a
ompetent number of mean Diameters in
e middle of every Foot or half Foot of the
uns depth, for which purpoſe the In-
ument is of excellent uſe, and may be
us applied.

Set the end of the Cane againſt the ſide
the Tun where the Diameter is ſought,
d keeping it level or parallel to the Tuns
ſe, draw out the Rule 'till the end thereof
uch the oppoſite ſide of the Tun, then
ep the Rule faſt from ſliding in or out,
d ſeek on the Line of Inches amongſt the
nall Figures (which increaſe towards the
ft hand) what number is cut by the head
the Cane, for that ſhews the Diameter in
ches and Tenths.

For Instance.

Admit that when the Cane and Rule is thus extended 'till they touch the two opposite sides of a Tun, I find the head of the Cane to cut 70 amongst the small Figures on the Line of Inches, this shews that the Diameter of that Tun is 70 Inches.

If the Diameter be more keep the Rule fixt at 70, and draw out the little Rod only.

Example.

(The Rule fixt at 70) suppose I draw out the little Rod 'till the end thereof stands against 20 amongst the great Figures on the Line of Inches, I add this 20 to 70 it makes 90, and so many Inches is the Cane and Rule extended, when drawn out as aforesaid.

This premised, I come now to the business of Inching of Tuns.

Probl.

Probl. VII.

...ere is a Tun whose Diameter at the bottom ...is 108 Inches, the Diameter at the top 93, and the depth 30, How many Ale Gallons will this Tun contain upon every Inch of the depth?

...O resolve this Question, there must first ... be known the whole Content of the Tun, ...d also the Area of the mean Diameter in ...e middle of every 10 or 12 Inches of ...e depth, and these may be thus found.

Take (with the Instrument) the Diame...r in the middle of every 10 Inches of the ...uns depth, and suppose in this Example ...e first (at 5 Inches from the top) be 95.5, ...e second (at 15 Inches from the top) ...00.5, and the third 105.5, these I set ...own as in the following Table.

This done, we may consider the Tun ...ther as Round or Square, and first to ...ch it as a Round Tun.

Set the Gauge-point (a g) to 1; then ...ainst the several Diameters already found ...ou have their respective Area's: So the ...rst will be 25,40, the second 28.31, the ...hird 31.00, these I set down in the Table

against their Diameters, and having added them together the Sum is 84.53, this Multiplied by 10 (or which is all one, remove the prick one place towards the Right hand) the Product is 845.3, the whole Content of the Tun.

Note, Here the Diameters being taken in the middle of every 10 Inches, there will be no use of Multiplication or Division in Inching the Tun, as there will be when the Diameters are taken in every Foot or half Foot, for here the Area's of the several Diameters do not only shew the mean Inch in the middle of every 10 Inches, but also the whole Content of those 10 Inches, if you remove the prick but one place more towards the Right hand. Thus the mean Inch of the last 10 Inches is 31.00, but if the prick be removed as abovesaid, it is 310, which is the Content of the Tun at 10 Inches deep, now according to this supposition, I reduce the several Contents (in the third Column) into Barrels, Firkins and Gallons of Beer, which I set down in the fourth Column, these added together are 23 Barrels, 1 Firkin, 8 Gallons and 3 tenths of a Gallon, which agrees with the Sum of the Numbers in the third Column.

Parts

Parts of the Tuns depth	Mean Diameters in the middle of every 10 Inches of the Tuns Depth.	Mean Area's or Contents of every 10 Inches of the Tuns dep.	Content of every 10 Inches in B.	F.	G.
10	95.5	25.40	7	0	2.0
10	100.5	28.13	7	3	2.3
10	105.5	31.00	8	2	4.0
30		84.53	23	1	8.3

By these Numbers thus found it will be easie to make a Table which shall shew the quantity of Liquor contain'd in the Tun at any depth, for which observe the following directions.

1. Set down the whole Content of the Tun in Barrels, Firkins, Gallons, and parts, in their respective Columns, and at the top of the first Column against the Content set 0, and under it the Tuns depth in Inches 1, 2, 3, 4, 5, *&c.* this done take the first mean Inches, *viz.* 25.4 and reduce it into Barrels, Firkins, and

In.	B.	F.	G.
0	23	1	8.30
1	22	3	0.9
2	22	0	2.5
3	21	1	4.1
4	20	2	5.7
5	19	3	7.3
6	19	0	8.9
7	18	2	1.5
8	17	3	3.1
9	17	0	4.7
10	16	1	6.3

Gall. Beer measure, it makes 0 : 2 : 7 : 4 : set this upon a scroll of paper and subtract it continually from the whole Content till you come at the 10th. Inch of the Tuns depth, which done, if you mistake not, the remainder there will be 16 : 1 : 6 : 3.

2. Take the second mean Inch, *viz.* 28, 13, this being reduced as the former is 0 : 3 : 1.13, Subtract this continually from the last remainder, till you come at 20 Inches deep, and there your remainder will be 8,2,4.

3. Take the third and last mean Inch and reduce and subtract it as before, and if your work be right there will be no remainder at the last Inch or bottom of the Tun; now the Table being made you may cast away the Fractions as useless, the use of this Table is obvious to the meanest Capacity, without any further explanation: For if you come to this Tun and find 2 Inches of the depth dry, the quantity of Liquor then in the Tun is,

In.	B.	F.	G.
11	15	2	5.1
12	14	3	4.0
13	14	0	2.9
14	13	1	1.7
15	12	2	0.6
16	11	2	8.5
17	10	3	7.3
18	10	0	6.2
19	9	1	5.1
20	8	2	4.0
21	7	3	0
22	6	3	5
23	6	0	1
24	5	0	6
25	4	1	2
26	3	1	7
27	2	2	3
28	1	2	8
29	0	3	4
30	0	0	0

22 B. 0 F. 2 G. If 7 Inches be dry there remain in a Tun but 18, 2, 1, *&c.* Thus for round Tuns.

Now suppose the Tun last mentioned were Square, and the sides at bottom and top equal to the Diameters of the last and the depth the same, the Diameters or sides in the middle of every 10 Inches of the Tuns depth will be the same as in the last, by which the several mean Inches, and also the whole Contents of every 10 Inches are found to be as in this Table.

Parts Tuns Depth.	*Diameter of the Tun*	*Mean Area's or Content of every 10 Inches.*	*Content of every 10 Inches in* B.	F.	G.
10	95.5	32.34	8	3	8.4
10	100.5	35.81	9	2	6.1
10	105.5	39.46	10	3	7.6
30		107.61	29	2	4.1

Thus, Set 282 upon B, to 95.5 the first Diameter upon A, then against 95.5 upon B is 32.34 the first mean Inch, and after the same manner find the second and third, which being reduced as in the last Example,

I find the whole Content to be 1076.1 Ale Gallons (or which is the same thing) 29 B. 2 F. 4.1 G. this being done you may proceed to Inch this Tun by the same directions which were given in the last Example.

Note, When the sides of a Tun are strait, if you take the Diameters only at the top and bottom, and also the depth of the Tun, the other Diameters may be found at once by the Rule: For Instance,

In the last Example the Diameter at the top is 93, at the bottom 108, the difference is 15, the Tuns depth was 30; suppose it were required to find the Diameters in the middle of every 10 Inches.

Set the depth 30 to the Difference 15 upon B, then against 5 (which is the middle of the first 10 Inches) upon A is 2.5 upon B, this added to 93, the lesser Diameter, is 95.5 the Diameter in the middle of the first 10 Inches; also against 15 (which is the middle of the second 10 Inches) is 7.5, this added to 93 is 100.5 the second Diameter: Lastly, against 25 (which is the middle of the last 10 Inches) is 12.5, this added to 93 gives 105.5 the last Diameter, the like may be done in any other: But it will be the surest way to take the Diameters actually and the more irregular the

the Tun is, the more Diameters must be taken.

Example.

Let there be a Tun whose Base at the bottom is Circular, and at the top Elliptical, suppose the Diameter at the bottom be 100 Inches, and the Axis or longest Diameter at the top 100, and the shortest 90, and the depth 30; How many Ale Gall. will this Tun contain at any depth proposed?

To Inch this Tun, I take the cross Diameters in the middle of every 4 Inches of the Tuns depth: Thus at 2 Inches from the top I find the longest Diameter 100, and the shortest 90, in the middle of the next four Inches (which is 6 Inches from the top) the longest Diameter is 100, and the shortest 93, and thus I find the rest which are as in this Table is express'd: Now having these Diameters, the Area or mean Inch in the middle of every 4 Inches of the Tuns depth may be thus found.

Set 359.05 upon B, to the longest Diameter, *viz.* 100 upon A: Then against the shorter Diameter upon B, is the Area in Ale Gallons; thus against 91 is 25.34, the Area

Area in the first 4 Inches, against 91
25.88 the second Area. In like man
against 95, you have 26.47 the third me
Inch: And so of the others as in the Table

Depth.	*Axis.*	*Shorter Diam*	*Mean Inch in Ale Gall.*	*Content of ea 4 Inches of t Tuns Dep*		
4	100	91	25.34	2	3	2.
4	100	93	25.88	2	3	4.
4	100	95	26.47	2	3	6.
4	100	97	27.02	3	0	0.0
4	100	99	27.57	1	2	1.1
20			132.28	13	0	5

These several Area's added toget
make 137.28, this Multiplied by 4, th
Product is 529.12, the whole Content o
the Tun, supposing it to stand level with-
out any drip or fall.

But most fixed Tuns are set a little in-
clining, that so the Liquor may be deeper
on one side than on the other, for the con-
venience of cleansing.

Therefore in Inching of such fixed Tun
there ought to be some allowance made for
the fall, for 'tis evident that any Tun whose
bases

[...]es are parallel will not contain so much [...]en it is set inclining, as when it stands [...]el.

As for Instance.

Admit the Tun last mention'd were so [...]c'd, that when the bottom is but just [...]er'd on one side, the Liquor is 4 Inches [...]p on the other side opposite; How much [...]st be allow'd for the fall of this Tun.

By the operation aforegoing the Area [...] the mean Diameter in the middle of the [...] last Inches (that is at 2 Inches from the [...]ttom) was found to be 27.57, this Multiplied by 4, is 110.28 Ale Gallons, the [...]ontent of the Tun at 4 Inches deep, the [...]lf of this is 55.14, and so much may be [...]low'd for the fall of the Tun, I there[...]re reduce this 55.14 into Barrels, Fir[...]ins and Gallons Beer measure, it gives [...]: 2: 1.14: which I set down in the [...]fth Column of the former Table against [...]he last mean Inch, and multiplying each [...]f the other mean Inches by 4, I reduce [...]he several Products into Barrels, Firkins [...]nd Gallons, which I also set down in the [...]ifth Column against their respective mean [...]nches, then these being added together the

Sum

Area in the first 4 Inches, against 91
25.88 the second Area. In like man
against 95, you have 26.47 the third me
Inch: And so of the others as in the Table

Depth.	Axis.	Shorter Diam	Mean Inch in Ale Gall.	Content of every 4 Inches of Tuns	Depth	
4	100	91	25.34	2	3	2.
4	100	93	25.88	2	3	4.
4	100	95	26.47	2	3	6.
4	100	97	27.02	3	0	0.
4	100	99	27.57	1	2	1.1
20			132.28	13	0	5

These several Area's added toget
make 137·28, this Multiplied by 4, the
Product is 529·12, the whole Content of
the Tun, supposing it to stand level with-
out any drip or fall.

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clining, that so the Liquor may be deeper
on one side than on the other, for the con-
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Therefore in Inching of such fixed Tuns
there ought to be some allowance made for
the fall, for 'tis evident that any Tun whose
bases

es are parallel will not contain so much
en it is set inclining, as when it stands
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As for Instance.

Admit the Tun last mention'd were so
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ver'd on one side, the Liquor is 4 Inches
ep on the other side opposite; How much
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By the operation aforegoing the Area
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ttom) was found to be 27.57, this Mul-
plied by 4, is 110.28 Ale Gallons, the
ontent of the Tun at 4 Inches deep, the
alf of this is 55.14, and so much may be
low'd for the fall of the Tun, I there-
re reduce this 55.14 into Barrels, Fir-
ins and Gallons Beer measure, it gives
: 2 : 1.14: which I set down in the
fth Column of the former Table against
he last mean Inch, and multiplying each
f the other mean Inches by 4, I reduce
he several Products into Barrels, Firkins
nd Gallons, which I also set down in the
ifth Column against their respective mean
nches, then these being added together the
Sum

Sum is 13 Barrels, 0 Firkins, 5 Gallo[ns] and .98 parts of a Gallon.

0	13	0	5.
1	12	1	7.
2	11	3	0.
3	11	0	1.
4	10	1	3.
5	9	2	4.
6	8	3	5.
7	8	0	6.
8	7	1	8.
9	6	2	8.6
10	6	0	c.
11	5	1	0.6
12	4	2	1.2
13	3	3	1.2
14	3	0	1.1
15	2	1	1.1
16	1	2	1.1

I set this at the top of the Table, then reducing the first mean Inch into Barrels, Firkins and Gallons, I subtract it four times from the whole Content, the remainder is 10 : 1 : 3.62: Do the like with second, third and fourth mean Inches, and you find the remainder at 16 Inches dry to be 1 : 2 : 1.14: and so much it takes to cover the bottom as was before observ'd.

The use of the Instrument in taking the demonstrations, and finding the Content of a Copper, is as follows.

Probl. VIII.

Let abcdea *in Fig.* 20. *represent a Copper whose Content is required.*

1. TO find the several Diameters and depth of the Copper, together with the Altitude of the Crown.

Take

Take a small Cord or Thread, make one end fast at *a*, and extend the other to the opposite side of the Copper at *e*, where make it fast, or cause some person to hold it very strait; this done, set one end of the Instrument in the bottom of the Copper at *b*, and move it to and fro 'till you find the nearest distance to the Thread as at *o*, this distance *b o*, is the depth of the Copper, suppose it be 44 Inches.

In like manner set the end of the Rule upon the top of the Crown at *c*, and take the nearest distance to the Thread as *c v*, suppose it be 36 Inches, this subtracted from *b o* 44, the remainder 8 is the Altitude of the Crown.

To find *b d* the Diameter of the bottom of the Crown:

Measure *a e*, the Diameter at the top, admit it be 115 Inches, then hold a Thread so as a Plummet at the end thereof may hang just over *b*; by this means you may find the distance *a o*, and on the other side *e s*, suppose each be 14.5, add these together and subtract their Sum (*viz.* 29.) from *a e*, 115 the remainder 86 is equal to *b d*, the Diameter at the bottom of the Crown, the Diameter which touches the top of the Crown may be found by the Instrument, suppose it be 91.4 Inches. Now

Now to find the Content of the Copper from the Crown upwards, (that is, the part *abcie*) the depth *vc* being 36 Inches, you may take a Diameter in the middle of every 6 Inches betwixt *v* and *c*, which suppose to be as in the second Column of the following Table, the numbers in the third Column are the respective Area in Ale Gallons, found by the Gauge-point as before; the fourth Column shews the Content of every 6 Inches in Barrels, Firkins and Gallons, Beer measure: These added together are 29 Barrels, 3 Firkins, 2.3 Gallons.

And so much will the Copper contain after the Crown is cover'd.

Now if the Crown be taken for the Frustum of a Sphere, the Content by the fifth Problem of the seventh Chap. will be found to be 83.3 Gallons.

But the Content may be more readily found and very near the truth: thus,

The Diameter *bd*, was found to be 86, the Area to this Diameter is 20.6, this Multiplied by ½ the Crowns Altitude, *viz.* 4, gives 82.4, the Content of the Crown, this subtracted from the Content of the part or portion *bcidnb*, the remainder is the quantity of Liquor that it will require to cover

over the Crown; the Content of the part *ciduh* may be thus found, *bi* is 91.4, and *bd* is 86, these added together are 177.4, the half 88.7 may be taken for a mean Diameter, the Area to this Diameter is 21.9, this Multiplied by 8, the Altitude, gives 175.2 the Content.

Now subtract 82.4 (the Content of the Crown) from 175.2, the remainder is 92.8, or 2 : 2 : 2.8, this added to the Content first found, *viz.* 29 : 3 : 2.5; gives 32 : 1 : 5 the Content of the whole Copper.

Parts of the depth.	*Diam.*	*Mean Inches.*	*Content of every 6 Inches in* B.	F.	G.
6	113.1	35.62	5	3	6.7
6	109.2	33.21	5	2	1.2
6	105.28	30.86	5	0	5.1
6	101.36	28.61	4	3	0.6
6	97.33	26.37	4	1	5.2
6	93.4	24.29	4	0	1.7
36	Sum	——	29	3	2.5
To cover the Crown			2	2	2.8
Content Copp.		——	32	1	5.3

The

The Content being thus found you m[ay] proceed to Inch the Copper by the sa[me] directions which were given for Inchi[ng] of Tuns. [See page 125.]

I shall conclude this Chapter with di-rections for Gauging a Mash-Tun.

The Corn Gallon (which is the measur[e] we here account by) contains 272.25 Cubic[k] Inches.

But Mr. *Dary* in his Complete Gauger, saith, that an indifferent sort of Mault, and of an indifferent Grinding, when three Worts shall have passed through it, is more compact by about a sixth part; he therefore concludes that 227 may be a Divisor for Square Mash-Tuns, and 288 for Round.

Probl. IX.

The Diameter of any round (or side of any Square) Mash-Tun, being given, to find how may Gallons of Maudt it will contain at one Inch deep.

For Round Mash-Tuns.

THe Diameter of that Circle whose Area is 227 is 17, and this may be call'd the Gauge-point for Round Mash-Tuns, and

d to find the Content of any ſuch : Set upon D to 1 upon C, then againſt any ameter upon D, you have the Content Gallons at one Inch deep: thus, if the ameter were 113, the Area is 44.3, that 5 Buſhels and 4 Gallons.

If the Maſh-Tun be Square or Oblong, e Content at one Inch deep may be thus und: Say,

As 227 to the length,
So is the breadth to the Content.

Example.

Suppoſe the length be 112, and the readth 80 Inches, How many Gallons ill this Tun contain at one Inch deep?

Set 227 upon A to 80 upon B, then againſt 112 upon A is 39.4 the Content pon B.

CHAP. IX.

Of Cask Gauging.

THe Content of a Cask is uſually found by the knowledge of the Demenſions, *viz.* the Diameter of the $\left\{\begin{matrix}\text{Bung}\\\text{Head}\end{matrix}\right\}$ and the length:

length: But it ought to be consider'd that although the Dimensions (abovesaid) of two Casks be equal, yet one may contain several Gallons more than the other, and therefore the Content of all Casks cannot be found by one and the same Rule, as will plainly appear by the Problems next following.

Probl. I.

There is a Cask (as Fig. 21.) which may be taken for the middle Frustum of a Spheroid intercepted between two Plains parallel cutting the Axis at Right-angles, suppose (a b) the Diameter at the Bung be 33 Inches, the Diameter at the Head d c 24.5, and the length e f 42 Inches, How many Ale or Wine Gallons will this Cask contain?

FOr resolving of this I shall lay down the same Rule (it being a true one) that several Authors have made use of, and it is this:

To twice the Square of the Diameter at the Bung, add the Square of the Diameter at the Head, then Multiply the Sum by the Casks length, and divide the Product by 1077 for Ale, or by 883 for Wine, the Quotient

[Qu]otient in either Case will be the Content [in] Gallons.

Example.

Twice the Square of 33 the [Bu]ng Diameter, is	2178
The Square of 24,5 the [He]ad Diameter, is	600.25
The Sum is	2778.25

This Multiplied by 42 the length, the Pro[du]ct is 116686.5, and this divided by [10]77, quotes 108.34 the Content in Ale [Ga]llons; and if it were divided by 883, [th]e Quotient would be 132.14, the Con[ten]t in Wine Gallons.

Now let there be another Cask, whose [D]iameter at Bung and Head, and also the [le]ngth are the same with those above men[ti]on'd, but suppose the Staves of the Cask [be] strait from the Bung to the Head, as [th]e Lines *a v d*, in Fig. 21. this Cask may [be] call'd the Frustum of two Cones abutting [u]pon one Common Base, (*viz. a b*) and the [C]ontent (by the Rule given in page 100.) [w]ill be found to be 97.4 Ale Gallons, which [i]s 10.94 Gallons less than the above found when

when taken for the Frustum of a Spheroi[d]. But for as much as there are but few (any) Casks whose Staves are strait fr[om] Bung to Head, the instance here give[n is] of no further use than to shew how m[uch] the Contents of two Casks may diff[er] whose Diameters and length are equal.

And if the Fig. last mention'd be d[uly] observ'd it will be easie to apprehe[nd] that the nearer the Staves of the Cask (b[e]tween the Bung and Head) are to the str[ait] Line *a v d*, the less will be the Conte[nt], and the nearer to the Curv'd Line *a o d*, t[he] more they will comprehend, and conseq[uen]tly the greater the Content.

Moreover, few or no Casks of these D[i]mensions will contain more than 108, Gallons, (the Content when taken fo[r a] Sphere) nor less than 97.4, (the Conte[nt] when Conical) therefore all the varie[ty] that can happen will be betwixt these tw[o]; for the Staves of the Cask will fall betwe[en] the Lines *a o d* and *a v d*, as in Fig. 2[?] and 19.

This premised, I shall next give tw[o] Rules by which (with that already give[n] for the Spheroid) the Content of any Ca[sk] may be found very near the truth.

First

First,

When the Staves of a Cask between the g and the Head, come nearer to the rved Line *aod*, than to the strait Line *d*, (as in Fig. 19.) such a Cask may r want of a fitter name) be call'd a Parabola, and the Content may be found by s Rule.

To 6 times the Square of the Bung Dieter, add 4 times the Square of the ad Diameter, then Multiply a tenth part the Sum by the length, and divide the oduct by 359 for Ale, or by 294 for ine, the Quotient will be the Content Gallons.

Example, (The Dimensions as before.)

Six times the Square of 33, e Bung Diameter is ———— } — 6534

Four times the Square of 24.5, e Head Diameter is ———— } — 2401

One tenth of the Sum is ——— 893.5

hich Multiplied by 42, the length gives 37514.4, this divided by 359, quotes 104.5, the Content in Ale Gallons.

Secondly,

Secondly,

If the Staves of a Cask between the Bung and the Head come nearer to the strait Line *aud*, than to the Curved Line *aod*, as in Fig. 22. (such a Cask may be call'd a Conoid and) the Content may be found by this Rule.

Let the Square of the Bung Diameter, the Square of the Head Diameter, and the Square of half the difference of the Diameters be added together, then Multiply that Sum by half the length, and divide the Product by 359 or 294, the Quotient will be the Content in Ale or Wine Gallons respectively:

Example, (The Dimensions as before.)

The Square of 33 is ———— 1089
The Square of 24.5 is ———— 600.2
The Square of $\frac{1}{2}$ the Diff. of the Diameter, (*viz.* 4.25.) is ———— 18.0

The Sum of these is ———— 1707.3

Multiplied by half the length (*viz.* 21.) gives 35853.51, this divided by 359 the Quotient will be 99.87, the Content in Ale Gallons.

Probl.

Probl. II.

The Dimensions, of a Cask being given, to find the Content by the Instrument.

TO do this we must first find a mean Diameter, that is, such a Diameter [as] shall reduce the Cask to a Cylinder, for [wh]ich purpose I have Calculated these three [Ta]bles, for the three varieties of Casks [abo]ve mention'd.

Spheroid.

Spheroid.

	0	1	2	3	4	5	6	7	8	9
1	0.67	0.74	0.81	0.87	0.94	1.01	1.08	1.15	1.21	1.28
2	1.35	1.42	1.49	1.56	1.62	1.69	1.76	1.83	1.90	1.97
3	2.04	2.11	2.17	2.24	2.31	2.38	2.45	2.52	2.59	2.66
4	2.73	2.80	2.87	2.94	3.01	3.08	3.15	3.22	3.29	3.36
5	3.43	3.50	3.57	3.64	3.71	3.78	3.86	3.93	4.00	4.07
6	4.14	4.21	4.28	4.35	4.42	4.49	4.56	4.63	4.71	4.78
7	4.85	4.92	4.99	5.06	5.14	5.21	5.28	5.35	5.42	5.49
8	5.57	5.64	5.71	5.78	5.85	5.93	6.00	6.07	6.14	6.21
9	6.29	6.36	6.43	6.51	6.58	6.65	6.72	6.79	6.87	6.94
10	7.01	7.08	7.15	7.22	7.29	7.36	7.44	7.51	7.58	7.65

Parabola.

1	0.61	0.67	0.73	0.79	0.85	0.91	0.97	1.03	1.09	1.16
2	1.22	1.28	1.34	1.41	1.47	1.53	1.59	1.65	1.71	1.77
3	1.84	1.90	1.97	2.03	2.09	2.15	2.22	2.28	2.34	2.41
4	2.47	2.53	2.60	2.66	2.72	2.78	2.85	2.91	2.98	3.04
5	3.11	3.17	3.23	3.30	3.36	3.43	3.49	3.56	3.62	3.69
6	3.75	3.81	3.88	3.94	4.01	4.07	4.14	4.20	4.27	4.33
7	4.40	4.47	4.53	4.60	4.66	4.73	4.79	4.86	4.92	4.99
8	5.06	5.12	5.19	5.25	5.32	5.39	5.45	5.52	5.58	5.65
9	5.72	5.78	5.85	5.92	5.98	6.05	6.12	6.19	6.26	6.32
10	6.39	6.45	6.51	6.57	6.63	6.69	6.76	6.82	6.88	6.94

Conoid.

1	0.51	0.56	0.61	0.66	0.71	0.77	0.82	0.87	0.92	0.98
2	1.03	1.08	1.13	1.19	1.24	1.29	1.35	1.40	1.46	1.51
3	1.56	1.62	1.67	1.73	1.78	1.84	1.89	1.94	2.00	2.06
4	2.11	2.17	2.22	2.28	2.33	2.39	2.45	2.50	2.56	2.61
5	2.67	2.73	2.78	2.84	2.90	2.96	3.01	3.06	3.12	3.18
6	3.24	3.30	3.36	3.41	3.47	3.53	3.59	3.64	3.70	3.76
7	3.82	3.88	3.94	4.00	4.06	4.11	4.17	4.23	4.29	4.35
8	4.41	4.47	4.53	4.59	4.65	4.71	4.77	4.83	4.89	4.95
9	5.01	5.07	5.13	5.19	5.25	5.31	5.37	5.44	5.49	5.56
10	5.62	5.67	5.72	5.78	5.83	5.88	5.93	5.98	6.03	6.08

And

And by these Tables were made those [th]ree Scales which are plac'd against the [li]ne of Inches on the Instrument.

Now to find the mean Diameter of any [C]ask either by the Tables or Scales, observe [th]e following Rule.

Having the difference of the Diameter [in] Inches and Tenths, seek the whole Inches [th]ereof in the first Column of the Table, [an]d the Tenths (if any be) at the Head, [th]en in the Angle of meeting you have a [N]umber, which being added to the Head [D]iameter, gives the mean Diameter sought.

Example.

Let the Dimensions be as in the former [P]roblem, the difference of Diameters was [8.]5: In the Table (for a Spheroid) against [8] on the side and under 5, I find 5.93, (and [th]e same I also find on the Scale for a Sphe[r]oid against 8.5 on the Line of Inches) [T]his 5.93, added to the Head Diameter, (*viz.* 24.5) the Sum is 30.43, the mean Diameter sought.

This being obtain'd, the Content of any Cask may be found by the Instrument at [o]ne operation, for which the proportion is:

As the Gauge-point is to the Casks leng
So is the mean Diameter to the Cont

Example.

The length 42, and the mean Diamet 30.43, as before,

Set the Gauge-point for Ale Gallons t 42 upon C, then against 30.43 upon D is 108.34, the Content in Ale Gallons which is the same as was found by the fir Example of the last Problem.

2. If the Cask be more Spheroidal th Conical (as Fig. 22.) seek the difference Diameters in the Table (or on the Line Inches against the Scale) for a Parabol by either you will find 5.39 to be add to the Head Diameter, which will make th mean Diameter 29.89.

Then,

As the Gauge-point to the length 42
So is 29.89 to 104.5 the Content.

3. If the Cask be more Conical tha Spheroidal (as Fig. 19.) find the differen of Diameters in the Table (or on the li

che

[ti]es against the Scale) for the Conoid by [ei]ther you will find 4.71, which added to [th]e Head Diameter gives 29.21, the mean.

Then,

As the Gauge-point to the length 42,
So is 29.21 to 99.86 the Content in Ale [G]allons.

And after this manner the Content of [a]ny Cask may be found by the Instrument [w]ith great expedition, and very near the [T]ruth. The following Table shews the Dimensions of several Casks, with their Contents, found by the Instrument in each [o]f the three Cases before mention'd.

Lengths	*Diameters*		*Contents.*		
	B.	H.	Spher.	Parab.	Conic.
48	34	24	128.69	123.22	117.68
40	29	24.5	86.92	84.91	82.20
36	31.5	24.5	86.38	83.76	80.45
34	26	20	55.29	53.55	51.37
30	28.1	24	60.00	58.80	57.20

As the Gauge-point is to the Casks leng
So is the mean Diameter to the Cont

Example.

The length 42, and the mean Diamet
30.43, as before,

Set the Gauge-point for Ale Gallons t
42 upon C, then against 30.43 upon D
is 108.34, the Content in Ale Gallons
which is the same as was found by the fir
Example of the last Problem.

2. If the Cask be more Spheroidal th
Conical (as Fig. 22.) seek the difference
Diameters in the Table (or on the Line
Inches against the Scale) for a Parabol
by either you will find 5.39 to be add
to the Head Diameter, which will make th
mean Diameter 29.89.

Then,

As the Gauge-point to the length 42
So is 29.89 to 104.5 the Content.

3. If the Cask be more Conical tha
Spheroidal (as Fig. 19.) find the differenc
of Diameters in the Table (or on the li

che

[lin]es against the Scale) for the Conoid by [ei]ther you will find 4.71, which added to [th]e Head Diameter gives 29.21, the mean.

Then,

As the Gauge-point to the length 42, *So* is 29.21 to 99.86 the Content in Ale [G]allons.

And after this manner the Content of [a]ny Cask may be found by the Instrument [w]ith great expedition, and very near the [t]ruth. The following Table shews the Dimensions of several Casks, with their Contents, found by the Instrument in each [o]f the three Cases before mention'd.

Lengths	*Diameters*		*Contents.*		
	B.	H.	Spher.	Parab.	Conic.
48	34	24	128.69	123.22	117.68
40	29	24.5	86.92	84.91	82.20
36	31.5	24.5	86.38	83.76	80.45
34	26	20	55.29	53.55	51.37
30	28.1	24	60.00	58.80	57.20

It may not be amiss to say somethi[ng] here of the Diagonal Line, which is a Li[ne] commonly known and made use of to fi[nd] the Contents of Casks, but if it be applie[d] to all sorts of Casks (as it generally is) [it] must needs be erronious, for by the fir[st] Problem of this Chapter, the Content o[f] the

				Ale Gall.
Spher	Figure	21	is	108.34
Parab.	Figure	22	is	104.50
Conoid.	Figure	19	is	99.86

and yet the Diagonal will be the same i[n] each, because the Diameters and lengt[hs] are the same.

To find the Diagonal of any Cask b[y] the Diameters and Lengths, the Rule is,

To the Diameter of the Bung, add th[e] Diameter of the Head, then to the Squar[e] of half their Sum, add the Square of hal[f] the length, the Square Root of that Su[m] is the Diagonal sought.

Example shall be in the last Cask of thi[s] Table whose Dimensions are these,

Bung

Bung Diameter 28.1 } Length 30.
Head Diameter 24 }

Sum is ——— 52.1
Half Sum is — 26.05
This Squared is ——— 678.7025
Square of ½ the length — 225

The Sum is ——— 903.7025

[W]hose Square Root (by the Lines C and D [o]n the Instrument) is 30.06, which is the [D]iagonal sought: Now if you look upon [a]ny Common Ganging Rod, against 30 [I]nches you will find 60 Gallons on the Diagonal for Beer, which agrees with the Content here found when the Cask was [t]aken for a Spheroid, but in the second Case the Content is but 58.8, and in the third but 57.2, whereas the Diagonal will give 60 in each, by this it may seem that the Diagonal was made for a Spheroid only, and that it may serve for all such, but that it will not do neither, for if the Dimensions of a Cask be these,

Bung Diameter 33 }
Head Diameter 24.5 } Inches.
Length ——— 42 }

 the

the Diagonal by the Rule above given will be found to be 35.6, as in Fig. 21.

Now 35.6 upon the Diagonal for Beer gives but a 100 Gallons, which is 8 Gallons too little, for the true Content of this Cask is 108.34, as appears by the first Problem of this Chapter: The Construction of the Diagonal Line or proportion, by which it may be made is this:

As the Content of any Cask is to the Cube of its Diagonal,

So is the Content of any other Cask (whose Dimensions are proportional to the Dimensions of the first) to the Cube of the Diagonal thereof.

This may be perform'd by the Instrument very easily.

For Instance.

Let the Dimensions of a Cask be,

$$\left.\begin{array}{ll}\text{Bung Diameter} & 28.1\\ \text{Head Diameter} & 24\\ \text{Length———} & 30\end{array}\right\}\text{Inches.}$$

By the former Examples the Content of this Cask (taken as a Spheroid) was found to be 60 Gallons, and the Diagonal 30 Inches.

Now

Now set 60 (the Content) on the first adius of the Line E, to 30 the Diagonal pon D, then against any Content upon E, u have the Diagonal upon D.

Thus against	10	upon E you have	16.52	upon D,
	20		20.80	
	30		23.80	
	40		26.20	
	95		35.00	

hich agrees with the Diagonal Line for eer, which you will find upon most Gauging ods, thus against 23.8 on the Line of ches on this Rule you have 30 on the iagonal, and so for any other Number.

So that a Diagonal Line being made true r one Cask, it will serve for all Casks hose Dimensions are proportional to the imensions of the Cask for which it was ade, and for none else.

Moreover, having the Dimensions and ontent of a Cask (taken in any Notion) o find the Dimensions of another Cask hat shall contain any certain quantity more r less than the Cask given.

Note, The Dimensions sought must be roportional to those given.

This will be perform'd by the Inſtrument, and the proportion is,

As the Content of the Cask given upon E, is to its length, Bung or Head Diameter upon D:

So is any other Content upon E, to the length, Bung or Head Diameter reſpectively ſought upon D.

Example.

There is a Cask whoſe

Bung Diameter	28.1	Inches,
Head Diameter	24	
Length ——	30	

and Content 60 Gallons.

I would have another Cask (proportional to this) that may contain 95 Gallons; *Quere*, What are the Dimenſions?

Set 60 the Content of the Cask given upon E, to 30 its length upon D, then againſt 95 upon E, is 35 upon D, the length ſought; and after the ſame manner you may find the Bung and Head Diameters; but the length being found the Diameters may be found by the Lines A and B, at one operation: For,

A

As the length given, is to the length found,

So are the Diameters given, to the Diameters sought.

Set 30 the length given upon B, to 35 the length (before found) upon A, then against 28.1 the Bung Diameter given upon B you have 32.8, and against 24 the Head Diameter you have 28: So the Dimensions of this Cask are,

Bung Diameter	32.8	Inches.
Head Diameter	28.0	
Length ———	35.0	

Now by these Dimensions the Content by the former Rules for a Spheroid will be found to be 95: This may be thought a needless digression, but it is sufficient to prove that the Diagonal Line will give the Content of some Casks more, of others less, than realy it is.

I shall next shew the use of the Rule in finding the Ullage or quantity of Liquor in a Cask which is not full, and that either when the Cask is posited with its Axis parallel to the Horizon, or perpendicular thereto.

This will be perform'd by the Instrument, and the proportion is,

As the Content of the Cask given upon E, is to its length, Bung or Head Diameter upon D:

So is any other Content upon E, to the length, Bung or Head Diameter respectively sought upon D.

Example.

There is a Cask whose

Bung Diameter	28.1	Inches,
Head Diameter	24	
Length	30	

and Content 60 Gallons.

I would have another Cask (proportional to this) that may contain 95 Gallons: *Quere*, What are the Dimensions?

Set 60 the Content of the Cask given upon E, to 30 its length upon D, then against 95 upon E, is 35 upon D, the length sought; and after the same manner you may find the Bung and Head Diameters: but the length being found the Diameters may be found by the Lines A and B, at one operation: For,

As

As the length given, is to the length found,

So are the Diameters given, to the Diameters sought.

Set 30 the length given upon B, to 35 the length (before found) upon A, then against 28.1 the Bung Diameter given upon B you have 32.8, and against 24 the Head Diameter you have 28: So the Dimensions of this Cask are,

Bung Diameter	32.8	Inches.
Head Diameter	28.0	
Length ———	35.0	

Now by these Dimensions the Content by the former Rules for a Spheroid will be found to be 95: This may be thought a needless digression, but it is sufficient to prove that the Diagonal Line will give the Content of some Casks more, of others less, than realy it is.

I shall next shew the use of the Rule in finding the Ullage or quantity of Liquor in a Cask which is not full, and that either when the Cask is posited with its Axis parallel to the Horizon, or perpendicular thereto.

In the first Case we must have given the whole Content of the Cask, the Bung Diameter, and also the quantity of the wet or dry part thereof.

Probl. III.

Let Fig. 21. *represent a Cask posited with the Axis* e f, *parallel to the Horizon, suppose the whole Content be* 108.34 *Gallons, the Bung Diameter* a b 33 *Inches, and the dry part* a s 8, *or the wet part* s b 25; *How many Gallons are contain'd in the Cask, and how many will it require to fill it full?*

For resolving this and such like Questions, there is a Line of Segments on the little Rod, which must be placed to slide against the Line A, or double Numbers, and upon these Lines the proportion is:

1. *As* the Bung Diameter upon the Numbers, *Is* to a 100 upon the Segments, *So* is the wet or dry parts on the Numbers, to a fourth Number on the Segments.

2. *As* 100 upon B, is to the Casks whole Content upon A,
So is the fourth Number last found to the Answer.

Example.

Example.

1. Set 33 the Bung Diameter on the Numbers, to a 100 on the Segments, then against 8 the dry Inches on the Numbers is .168 on the Segments.

2. Set 100 upon B, to 108.34 the Casks whole Content upon A, then against .168 upon B, you have 18.2 upon A, and so many Gallons it will take to fill up the Cask, this subtracted from 108.34, the whole Content, there rests 90.14 the quantity of Liquor in the Cask; which may otherwise be found thus, having set 33 the Bung Diameter to 100 on the Segments, against 25 the wet Inches on the Numbers, you have 8.32 on the Segments.

Then,

As 100 upon B, is to 108.34 upon A,
So is 8.32 upon B, to 90.138 upon A:
Which being the same as before is a proof of the work.

Note, The Line of Segments on this Rule is made for Spheroid, and is therefore more exact for all Bulging Casks than the Tables of Segments, which are proper only for a Cylinder.

Probl.

Probl. IV.

There is a Cask (as Fig. 23.) whose Dimensions are,

Length ——	42	*Inches.*
Bung Diameter	33	
Head Diameter	24.5	

The Content by the former Rules is 108.34 *Ale Gallons.*

NOw suppose this Cask stand upon one head with its Axis Perpendicular to the Horizon, and the depth of the Liquor *ny* be 34 Inches, and the dry part of the Axis *nd* 8 Inches: How many Ale Gallons are contain'd in the Cask, and how many such Gallons will it take to fill it up?

This Question may be resolved by the Pen without knowing the Diameter of the Surface of the Liquor, for which you have two several Rules in *Dary*'s *Complete Gauger:* But to resolve it by those his Rules is a long (and to some a difficult) work. I shall therefore shew how to perform it by this Instrument, in order whereunto, we must first find the Diameter of the Surface of the Liquor, and that may be done after this manner.

Having

Having a Thread with a Plummet, fasten the Thread to the end of the Gauging-Rod, which you must so place upon the head of the Cask, that the Thread hanging strait down may just touch the side of the Cask, as the Line *core*, in Fig. 23. this done find the Distance between the Thread and the side of the Cask right against the Surface of the Liquor (as *os* in the Fig.) suppose it be 1.75, this doubled is 3.5, which subtracted from the Bung Diameter *rg* 33, the remainder will be 29.5, equal to *snv*, the Diameter of the Surface of the Liquor.

Next find a mean Diameter between the Head and the Surface of the Liquor: thus, *snv* 29.5, less by *adb* 24.5, is 5, this sought in the Table or Scale, for a Spheroid, gives 3.43, which added to the Head Diameter 24.5, is 27.93, the mean Diameter sought: Then set the Gauge-point to 8 (the depth *dn*) upon C, and against 27.93 upon D, you have 17.4 upon C, and so many Gallons it will take to fill up the Cask, and this 17.4 subtracted from 108.34 the whole Content, the remainder is 90.94 Gallons, the quantity of Liquor in the Cask.

To

To prove this, find the Content of that part of the Cask contain'd betwixt the Surface of the Liquor and the Bung Diameter: thus,

The depth *nc* is 13 Inches, *sv* is 29.5, and *rg* 33, the mean Diameter between *sv* and *rg* will be found by the former Rules to be 31.88: Therefore, Set the Gauge-point to 13 the depth, then against 31.88 the mean Diameter, you have 36.76 the Content of the portion *snvgxr*, to which add the Content above found, *viz.* 17.4, the Sum is 54.16, this doubled is 108.32 the whole Content as before, therefore this Rule is true enough for practice.

Probl. V.

Any Number of Gallons being given, to reduce the same into Barrels of Beer or Ale.

First for Beer Barrels.

SEt 36 upon B to 1 upon A, then against any Number of Gallons upon B, you have the Number of Barrels upon A.

Example.

Example.

Suppose the Number of Gallons to be educed as aforesaid were 2358.

Set 36 upon B to 1 upon A, then against 358 upon B, you have 65.5, the Answer pon A; so that 2358 Gallons are equal to 5 Barrels and an half.

In like manner without moving the Rule

gainst	889 900 2457 2610 2856	Gallons upon B you have	24.694 25.000 68.250 72.500 79.333	Bar. upon A.

So 889 Gallons contains 24 Barrels, and .694 parts, which is 25 Gallons, as may be seen without moving the Rule, for against .694 upon A is 25 upon B, and the like for any other Decimal of a Barrel.

Contrarywise.

As the Rule now stands, against any Number of Barrels upon A you have the Number of Gallons contain'd therein upon B, thus against 25 Barrels you have 900 Gallons, *&c.*

To

To reduce Gallons into Ale Barrels is the same with the former, if instead of 36, you set 32 against 1, for this being done, against any Number of Gallons upon B you have the Number of Barrels and parts upon A, and the Contrary.

Probl. VI.

Any Number of Beer Barrels being given, to find how many Ale Barrels are contain'd therein, and the Contrary.

FOr this the proportion is,

As 32 to 36,
So are the Beer Barrels to the Ale Barrels.

Or,

As 36 to 32,
So are the Ale Barrels to the Beer Barrels.

Therefore,

Set 32 upon B, to 36 upon A, then against any Number of Beer Barrels, you have the Number of Ale Barrels contain'd therein:

Thus,

Thus, the Rule being ſet as above directed,

Againſt	20	B. Bar.	22.5	Ale Bar.	
	28	upon B	31.5	upon A.	
	40	you have	45.0		
	60		67.5		

Contrarywiſe againſt any Number of Ale Barrels upon A, you have the Number of Beer Barrels upon B.

Probl. VII.

Any Number of Ale Gallons being given, to reduce them into Wine Gallons, and the Contrary.

For this the proportion is,

As 231 to 282,

So is any Number of Ale Gallons to the Number of Wine Gallons.

Or,

As 282 to 231,

So is any Number of Wine Gallons to the Number of Ale Gallons.

Therefore,

Therefore,

Set 231 upon B, to 282 upon A, then against any Number of Ale Gallons upon B, you have the Number of Wine Gallons upon A: thus,

$$\text{Against}\left\{\begin{array}{l}30\\40\\50\\54\end{array}\right\}\begin{array}{l}\text{Ale Gall.}\\\text{upon B,}\\\text{you have}\end{array}\left\{\begin{array}{l}36.6\\48.8\\61.0\\65.92\end{array}\right\}\begin{array}{l}\text{Wine}\\\text{Gall.}\\\text{upon}\\\text{A,}\end{array}$$

Contrarywise.

Against any Number of Wine Gallons upon A, you have the Number of Ale Gallons upon B.

To Conclude this Chapter, I shall shew how to find (by the Instrument) what Sum of Money the Excise of any Number of Barrels of Strong Beer, Strong Ale, or Small Beer will amount unto.

And first for Victualers.

The Duty of one Barrel of Strong Beer or Ale, being 2 *s.* 6 *d.* the Duty of 8 Bar. will be one Pound: Therefore the proportion is,

As

As 8 is to 1,
So is any Number of Barrels to the Duty
o be paid for the same.

Therefore,

Set 8 upon B to 1 upon A, then against
ny Number of Barrels upon B, you have
he Duty upon A: And thus (the Rule be-
ng set as above directed) the Duty of 20
Barrels will be found to be 2.5, that is,
l. 10 *s.* and after the same manner you
may find that,

The Duty of	30	Barr. is	3.75
	40		5.00
	60		7.50
	100		12.50
	160		20.00

The value of the parts of a Pound may
be known by Inspection, if you observe the
directions given in page 20, *&c.*

For small Beer thus,

The Duty of one Barrel of Small Beer is
6 *d.* Therefore the Duty of 40 Barrels is
one Pound: Hence the proportion is,
As

As 40 to 1,
So is any Number of Barrels to the Duty sought.

Therefore,

Set 40 upon B to 1 upon A, then against any Number of Barrels upon B, you have the Duty upon A, and thus the

				l.
Duty of	100	Barr. is		2.5
	160			4.0
	300			7.5

Secondly for Common Brewers.

Note, A Common Brewer hath an allowance of 3 Barrels in 23 for Beer, and 2 Barrels in 22 for Ale. So that a Common Brewer pays but the same Duty for 23 Barrels of Beer, that a *Victualer* pays for 20 Barrels, which for strong Beer is 2 *l.* 10 *s.* or 2.5 *l.*

Therefore the proportion is,

As 23 is to 2.5,
So is any Number of Barrels to the Duty sought.

There-

Therefore,

Set 23 upon B, to 2.5 *l.* upon A, then against any Number of Barrels upon B, you have the Duty upon A, thus if the Number of Barrels

$$\text{were} \begin{Bmatrix} 46 \\ 69 \end{Bmatrix} \text{the Duty is} \begin{Bmatrix} 5.0 \\ 7.5 \end{Bmatrix} l.$$

For Ale the proportion is,

As 22 to 2.5,
So is any Number of Barrels to the Duty sought.

Therefore,

Set 22 upon B, to 2,5 upon A, then against any Number of Barrels of Ale upon B, you have the Duty upon A, and thus the Duty of 44 Barrels will appear to be 5 *l.* &c.

The proportion for small Beer is,

As 46 to 1,
So is any Number of Barrels to the Duty required.

But

But forasmuch as the exact Duty for Common Brewers cannot be found by the Instrument without some difficulty, I have here inserted two Tables (one for Strong and Small Beer, and the other for Strong Ale) which (though very short and concise) will shew the exact Duty for any Number of Barrels, from 1 to 3300 and upwards, and their use will be render'd very plain and easie, by the Directions and Examples following.

1. If the Number of Barrels of Strong or Small Beer given be less than 23, seek it in the first Column of the first Table, and against it you have the exact Duty in Pounds, Shillings, Pence, and 23th. parts of a Peny, which parts of a Peny are reduced into Farthings, and exprest by the small Figures which stand over the parts. Thus, the Duty of 21 Barrels of Strong Beer will be found to be 2 *l.* 5 *s.* 7 *d.* and $\frac{19}{23}$ parts of a Peny or 3 Farthings, as is signified by the small Figure ^{3} over the 19: The like for Small Beer, *&c.*

2. For any Number above 23, seek it in some of the Columns of Barrels in the Table, and if you cannot find the same Number, take the next less, and set down the sum of Money against it, then subtract the Number

A *TABLE* of Allowances for Brewers for Strong and small Beer.

	X				VI			
	l.	*s.*	*d.*	23	*l.*	*s.*	*d.*	23
¼	0	0	6	12^{2}	0	0	1	7^{1}
½	0	1	1	1	0	0	2	14^{2}
¾	0	1	7	13^{2}	0	0	3	21^{3}
1	0	2	2	2	0	0	5	5
2	0	4	4	4	0	0	10	10^{1}
3	0	6	6	6^{1}	0	1	3	15^{2}
4	0	8	8	8^{1}	0	1	8	20^{3}
5	0	10	10	10^{1}	0	2	2	2
6	0	13	0	12^{2}	0	2	7	7^{1}
7	0	15	2	14^{2}	0	3	0	12^{2}
8	0	17	4	16^{2}	0	3	5	17^{2}
9	0	19	6	18^{3}	0	3	10	22^{3}
10	1	1	8	20^{3}	0	4	4	4
11	1	3	10	22^{3}	0	4	9	9^{1}
12	1	6	1	1	0	5	2	14^{2}
13	1	8	3	3	0	5	7	19^{3}
14	1	10	5	5	0	6	1	1
15	1	12	7	7^{1}	0	6	6	6^{1}
16	1	14	9	9^{1}	0	6	11	11^{2}
17	1	16	11	11^{1}	0	7	4	16^{2}
18	1	19	1	13^{2}	0	7	9	21^{3}
19	2	1	3	15^{2}	0	8	3	3
20	2	3	5	17^{2}	0	8	8	8^{1}
21	2	5	7	19^{3}	0	9	1	13^{2}
22	2	7	9	21^{3}	0	9	6	18^{3}

	X		VI	
Br.	*l.*	*s.*	*l.*	*s.*
23	2	10	0	10
46	5	00	1	00
69	7	10	1	10
92	10	00	2	00
115	12	10	2	10
138	15	00	3	00
161	17	10	3	10
184	20	00	4	00
207	22	10	4	10
230	25	00	5	00
253	27	10	5	10
276	30	00	6	00
299	32	10	6	10
322	35	00	7	00
345	37	10	7	10
368	40	00	8	00
391	42	10	8	10
414	45	00	9	00
437	47	10	9	10
460	50	00	10	00
483	52	10	10	10
506	55	00	11	00
529	57	10	11	10
552	60	00	12	00
575	62	10	12	10
598	65	00	13	00
621	67	10	13	10
644	70	00	14	00
667	72	10	14	10
690	75	00	15	00

Place this Table between Pag. 166, and 167.

	IX X		VI			X		VI	
Bar.	l.	s.	l.	s.	Bar.	l.	s.	l.	s.
713	77	10	15	10	1403	152	10	30	10
736	80	00	16	00	1426	155	00	31	00
759	82	10	16	10	1449	157	10	31	10
782	85	00	17	00	1472	160	00	32	00
805	87	10	17	10	1495	162	10	32	10
828	90	00	18	00	1518	165	00	33	00
851	92	10	18	10	1541	167	10	33	10
874	95	00	19	00	1564	170	00	34	00
897	97	10	19	10	1587	172	10	34	10
920	100	00	20	00	1610	175	00	35	00
943	102	10	20	10	1633	177	10	35	10
966	105	00	21	00	1656	180	00	36	00
989	107	10	21	10	1679	182	10	36	10
1012	110	00	22	00	1702	185	00	37	00
1035	112	10	22	10	1725	187	10	37	10
1058	115	00	23	00	1748	190	00	38	00
1081	117	10	23	10	1771	192	10	38	10
1104	120	0	24	00	1794	195	00	39	00
1127	122	10	24	10	1817	197	10	39	10
1150	125	00	25	00	1840	200	00	40	00
1173	127	10	25	10	1863	202	10	40	10
1196	130	00	26	00	1886	205	00	41	00
1219	132	10	26	10	1909	207	10	41	10
1242	135	00	27	00	1932	210	00	42	00
1265	137	10	27	10	1955	212	10	42	10
1288	140	00	28	00	1978	215	00	43	00
1311	142	10	28	10	2001	217	10	43	10
1334	145	00	29	00	2024	220	00	44	00
1357	147	10	29	10	2047	222	10	44	10
1380	150	00	30	00	2070	225	00	45	00

	X		VI			X		VI	
Bar.	l.	s.	l.	s.	Bar.	l.	s.	l.	s.
2093	227	10	45	10	2783	302	10	60	10
2116	230	00	46	00	2806	305	00	61	00
2139	232	10	46	10	2829	307	10	61	10
2162	235	00	47	00	2852	310	00	62	00
2185	237	10	47	10	2875	312	10	62	10
2208	240	00	48	00	2898	315	00	63	00
2231	242	10	48	10	2921	317	10	63	10
2254	245	00	49	00	2944	320	00	64	00
2277	247	10	49	10	2967	322	10	64	10
2300	250	00	50	00	2990	325	00	65	00
2323	252	10	50	10	3013	327	10	65	10
2346	255	00	51	00	3036	330	00	66	00
2369	257	10	51	10	3059	332	10	66	10
2392	260	00	52	00	3082	335	00	67	00
2415	262	10	52	10	3105	337	10	67	10
2438	265	00	53	00	3128	340	00	68	00
2461	267	10	53	10	3151	342	10	68	10
2484	270	00	54	00	3174	345	00	69	00
2507	272	10	54	10	3197	347	10	69	10
2530	275	00	55	00	3220	350	00	70	00
2553	277	10	55	10	3243	352	10	70	10
2576	280	00	56	00	3266	355	00	71	00
2599	282	10	56	10	3289	357	10	71	10
2622	285	00	57	00	3312	360	00	72	00
2645	287	10	57	10	3335	362	10	72	10
2668	290	00	58	00	3358	365	00	73	00
2691	292	10	58	10	3381	367	10	73	10
2714	295	00	59	00	3404	370	00	74	00
2737	297	10	59	10	6808	740	00	148	00
2760	300	00	60	00	10212	1110	00	222	00

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A TABLE of Allowances for Brewers for Ale.

Bar.	l.	s.	d.	22
$\frac{1}{4}$	0	0	6	18^3
$\frac{1}{2}$	0	1	1	14^2
$\frac{3}{4}$	0	1	8	10^2
1	0	2	3	6^1
2	0	4	6	12^2
3	0	6	9	18^3
4	0	9	1	2
5	0	11	4	8^1
6	0	13	7	14^2
7	0	15	10	20^3
8	0	18	2	4
9	1	0	5	10^2
10	1	2	8	16^2
11	1	5	0	0
12	1	7	3	6^1
13	1	9	6	12^2
14	1	11	9	18^3
15	1	14	1	2
16	1	16	4	8^1
17	1	18	7	14^2
18	2	0	10	20^3
19	2	3	2	4
20	2	5	5	10^2
21	2	7	8	16^2

Br.	l.	s.
22	2	10
44	5	00
66	7	10
88	10	00
110	12	10
132	15	00
154	17	10
176	20	00
198	22	10
220	25	00
242	27	10
264	30	00
286	32	10
308	35	00
330	37	10
352	40	00
374	42	10
396	45	00
418	47	10
440	50	00
462	52	10
484	55	00
506	57	10
528	60	00
550	62	10
572	65	00
594	67	10
616	70	00
638	72	10
660	75	00

Bar.	l.	s.
682	77	10
704	80	00
726	82	10
748	85	00
770	87	10
792	90	00
814	92	10
836	95	00
858	97	10
880	100	00
902	102	10
924	105	00
946	107	10
968	110	00
990	112	10
1012	125	00
1034	127	10
1056	130	00
1078	132	10
1100	135	00
1122	137	10
1144	140	00
1166	142	10
1188	145	00
1210	147	10
1232	150	00
1254	152	10
1276	155	00
1298	157	10
1320	150	00

Place this Table between Pag. 166, and 167.

Bar.	*l.*	*s.*	Bar.	*l.*	*s.*	Bar.	*l.*	*s.*
1342	152	10	2002	227	10	2662	302	10
1364	155	00	2024	230	00	2684	305	00
1386	157	10	2046	232	10	2706	307	10
1408	160	00	2068	235	00	2728	310	00
1430	162	10	2090	237	10	2750	312	10
1452	165	00	2112	240	00	2772	315	00
1474	167	10	2134	242	10	2794	317	10
1496	170	00	2156	245	00	2816	320	00
1518	172	10	2178	247	10	2838	322	10
1540	175	00	2200	250	00	2860	325	00
1562	177	10	2222	252	10	2882	327	10
1584	180	00	2244	255	00	2904	330	00
1606	182	10	2266	257	10	2926	332	10
1628	185	00	2288	260	00	2948	335	00
1650	187	10	2310	262	10	2970	337	10
1672	190	00	2332	265	00	2992	340	00
1694	192	10	2354	267	10	3014	342	10
1716	195	00	2376	270	00	3036	345	00
1738	197	10	2398	272	10	3058	347	10
1760	200	00	2420	275	00	3080	350	00
1782	202	10	2442	277	10	3102	352	10
1804	205	00	2464	280	00	3124	355	00
1826	207	10	2486	282	10	3146	357	10
1848	210	00	2508	285	00	3168	360	00
1870	212	10	2530	287	10	3190	362	10
1892	215	00	2552	290	00	3212	365	00
1914	217	10	2574	292	10	3234	367	10
1936	220	00	2596	295	00	3256	370	00
1958	222	10	2618	297	10	3278	372	10
1980	225	00	2640	200	00	3300	375	00

ber found from the Number given, the remainder (which will ever be less than 23) being found in the first Column of the Table gives you a Sum of Money, which added to the former is the exact Duty required.

Example 1.

What Sum of Money will the Duty of 1306 *Barrels of Strong Beer amount unto?*

See the Work:

			l.	*s.*	*d.*	*pt.*
Number given	1306					
Next less *per* Tab.	1288	=	140	00	0	00
Remainder ——	18	=	001	19	1	13
The exact Duty is ——			141	19	1	13

That is, 141 *l.* 19 *s.* $1\frac{1}{2}$ *d.*

Example 2.

What Sum of Money will the Duty of 2237 *Barrels of Strong Ale amount unto?*

			l.	*s.*	*d.*	*pt.*
The Num. given	2237					
Next less *per* Tab.	2222	=	252	10	0	0
Remainder is ——	15	=	1	14	1	2
The Duty is ——			254	04	1	2

A

Note, The parts in this Table are 22th parts of a Peny, and are reduced into Farthings as the former.

CHAP. X.

AMongst the several Authors that have Treated of the Line of Numbers, I do not find any who have omitted to shew its usefulness in the resolution of such Questions as concern Interest and Annuities.

And seeing the Answer to any Question resolvable by the Line of Numbers, will be more or less exact as the Line is longer or shorter, and the Lines on this Instrument being longer than any other which are ordinarily made use of; I shall here shew their use in the resolution of some Questions, relating both to Simple and Compound Interest: And first,

Of Simple Interest.

Probl. I.

If 100 l. *in* 1 *year*, 12 *months*, *or* 365 *days*, *doth gain* 6 l. *or Amount to* 106 l. (*at* 6 per *Cent*, per An.)

How

How much shall any other Sum gain or amount unto in any other Time at the same Rate?

THis Problem doth comprehend several Questions, the chief whereof are the six next following.

Quest. I.

To find the Interest of any Sum of Money in one year, at the Rate of 6 per Cent. per An.

FOr resolving of this Question, the proportion is,

As 100 *l.* Principal, is to 6 its Interest in one year,

So is any other Sum to its proportional Interest.

Therefore,

Set 100 (in the middle) upon A, to 6 (the Interest thereof) upon B, this done against any other Sum upon A, you have the Interest upon B. Thus the Lines being set as above directed against 250 upon A, is 15 upon B; which is the Interest of 250 *l.* in one year, and without

I moving

moving the Rule I likewise find that if the Principal

	l.		*l.*
be	1000	the Interest will be	60
	850		51
	600		36
	360		21.6
	130		7.8
	85		5.1
	50		3
	20		1.2

Note, The parts of a Pound may be reduced to Shillings and Pence by the Rule given in page 47, and when there be Shillings and Pence in the Principal, they must be reduced to a Decimal, by the directions given in page 46.

For Instance.

How much is the Interest of 56 l. 5 s. 6 d. *in one year?*

The Shillings and Pence being reduced as above directed, the Sum will be 56.275 *l.*

Then say,

As 100 upon A, is to 6 upon B,
So is 56.275 upon A, to 3.3765 upon B.

The

The Answer is, 3.3765, which being re-
ced is 3 *l.* 7 *s.* 6 *d.* 1 *f.*

Quest. II.

find the Amount of any Sum of Money in one year at 6 per Cent. per An.

THis may be done by adding the Interest (found by the last) to the Principal; or by the Instrument the proportion is,

As 100 is to 106,
So is any other Sum to the Amount thereof in one year.

Therefore,

Set 100 upon B, to 106 upon A, then against any other Sum upon B, you have the Amount upon A: Thus (the Rule being set as above directed) you will find that if the Principal

l.		*l.*
1000		1060
850		901
600		636
be 360	the Amount in	381.6
130	one year will be	137.8
85		90.1
50		53
20		21.2

Quest.

Quest. III.

To find the Interest that will be due for a Sum of Money, in any Time propounded, Years, Months, or Days.

Rule.

FInd (by the first Quest.) the Interest the Sum given in one year:

Then say,

As 1 year, 12 months, or 365 days to the Interest found,
So is the Time propounded (in years, months, or days,) to the Interest sought.

I. For Years.

Example 1. *What is the Interest of* 250 l *in* 6 *years, at* 6 per Cent. per An.

1. Set 100 upon A, to 6 upon B, then against 250 upon A, is 15 upon B, the Interest in one year.

2. *As*

2. *As* 1 upon A, is to 15 upon B,
So is 6 upon A, to 90 upon B, the Interest required.

II. For Months.

Example 2. *What is the Interest of* 250 l. *for three Months?*

The Interest of 250 *l.* in 12 months by the last Question is 15 *l.*

Therefore say,

As 12 upon B, is to 15 upon A,
So is 3 upon B, to 3.75 upon A: That is, 3 *l.* 15 *s.* the Interest of 250 *l.* for three months.

III. For Days.

Example 3. *How much is the Interest of* 250 l. *for* 146 *days?*

Find (as before) the Interest of 250 for one year, which is 15 *l.* Then,

Set 365 upon A, to 15 upon B, and against 146 upon A, you have 6 upon B, which is the Interest required.

Queſt. III.

To find the Intereſt that will be due for a Sum of Money, in any Time propounded, in Years, Months, or Days.

Rule.

FInd (by the firſt Queſt.) the Intereſt of the Sum given in one year:

Then ſay,

As 1 year, 12 months, or 365 days, is to the Intereſt found,

So is the Time propounded (in years, months, or days,) to the Intereſt ſought.

I. For Years.

Example 1, *What is the Intereſt of* 250 l. *in 6 years, at* 6 per Cent. per An.

1. Set 100 upon A, to 6 upon B, then againſt 250 upon A, is 15 upon B, the Intereſt in one year.

2. *As*

2. *As* 1 upon A, is to 15 upon B,
So is 6 upon A, to 90 upon B, the Interest required.

II. For Months.

Example 2. *What is the Interest of* 250 l. *for three Months?*

The Interest of 250 *l.* in 12 months by the last Question is 15 *l.*

Therefore say,

As 12 upon B, is to 15 upon A,
So is 3 upon B, to 3.75 upon A: That is, 3 *l.* 15 *s.* the Interest of 250 *l.* for three months.

III. For Days.

Example 3. *How much is the Interest of* 250 l. *for* 146 *days?*

Find (as before) the Interest of 250 for one year, which is 15 *l.* Then,
Set 365 upon A, to 15 upon B, and against 146 upon A, you have 6 upon B, which is the Interest required.

In all these and such like Cases, the In-
terest thus found being added to the Prin-
cipal gives the Amount in the time propo-
sed.

But the Interest and also the Amount o
any Sum of Money (especially if it be grea
may be more exactly found by the follow
ing Table.

In the first Column of which you hav
the several Rates *per Cent. per An.*

The second Column shews the Interest o
one Pound for one year at each respectiv
Rate, found by dividing the several Rat
by 100.

The third Column shews the Interest o
one Pound for one month, and these a
found by dividing the respective Rates b
1200.

The numbers in the fourth Column shew
the Interest of one Pound for one day
and are gotten by dividing the several Rate
by 36500.

The use of this Table is, to find the In-
terest or Amount of any Sum of Money fo
any number of years, months or days, a
any Rate therein exprest: For which ob
serve this general Rule.

Multiply the Tabular number (which stands against the Rate propounded and under the Title year, month or day, according as the Question is) by the number of years, months or days, for which you seek the Interest, the Product will be the Interest of one Pound for that time; which Multiplied by the Sum given, the last Product will shew the Interest sought.

Rates per Cent.	*Year.*	*Month.*	*Day.*
4	.04	.00333	.000109589
5	.05	.00416	.000136986
6	.06	.005	.000164383
7	.07	.00583	.000191781
8	.08	.00666	.000219178
9	.09	.0075	.000246575
10	.10	.00833	.000273972

Example: *What is the Interest of* 800 l. *for* 300 *days, at* 6 per Cent. per An.

Here the Question being for *days*, I seek in the Column under the Title *Day*, and against 6 the Rate propounded, and find

find .000164383, this Multiplied by 300 (the number of days) gives .0493149, which is the Interest of one Pound for 300 days; now this Multiplied by 800 (the Sum given) the Product will be 39.45192: that is, 39*l.* 9*s.* 1*f.* and so much is the Interest of 800*l.* for 300 days, to which if you add the Principal (*viz.* 800.) the Sum will be 839*l.* 9*s.* 1*f.* the Amount of 800*l.* in 300 days: Or (for the Amount) thus, find the first Product (*viz.*) the Interest of one Pound for the number of years, months or days propounded: this done, add an Unit thereto, the Sum will be the Amount of one Pound in that time; which Multiplied by the sum whose Amount you seek, the last Product is the Answer.

Thus in the last Example the first Product was .0493149, to which add an Unit, the Sum is 1.0493149, (the Amount of one Pound in 300 days) this Multiplied by 800 the Sum given, the Product is 839.45192 the Amount as before.

This Question wrought by the pen will be very exact, though the time be long and Sum great, but any ordinary Question may be resolved true enough by the Instrument.

Quest.

Quest. IV.

Let there be supposed a Sum of Money presently due, also the Sum it did amount unto in a time unknown, at a certain Rate per Cent. per An. *To find in what time it is so increased.*

The Rule.

Subtract the Sum proposed from the Amount, the remainder is the Interest for the time sought, which divide by the Principal, (or Sum due) then if the Quotient thus found be divided by the Interest of one Pound for one year, month or day, (found by the Table above) according to the tenure of the Question, the last Quotient will be the time sought in years, months or days, respectively.

Example.

If 252 l. *hath been forborn 'till with the Interest at* 6 per Cent. per An. *it is increased to be* 270 l. 18 s. *(or* 270.9.*) How many months hath it been forborn?*

The amount ———————— 270.9
Sum first given ———————— 252.0

The Remainder ———— 18.9

Is the Interest for the time sought: This divided by 252, the Quotient is .075.

Now the time sought being months, I find in the former Table the Interest of one Pound for one month at 6 *per* Cent. (*viz.* .005) by which I divide the former Quotient (*viz.* .075;) the last Quotient is 15, the number of months sought.

To work this by the Instrument, find the Interest as above, and then the proportion is,

1. *As* the Sum due upon B, is to 1 upon A,

So is the Interest thereof upon B, to a fourth term upon A.

2. *As* the Tabular Number (found as above) upon B, is to 1 upon A;

So is the fourth term upon B, to the time sought upon A.

Thus in the last Example, the Interest was found to be 18.9:

Therefore,

Therefore,

Set 252 upon B, to 1 upon A, then against 18.9 upon B, is .075 upon A.

Again,

Set .005 (the Interest of one Pound for one month) upon B, to 1 upon A, then against .075 upon B, is 15 (the months sought) upon A.

Quest. V.

A Sum of Money proposed, and also the Interest due for the same for any time given, to find at what Rate of Interest it became due.

Rule.

Multiply the Interest by 100, and divide the Product by the Principal Multiplied by the time given, this done the Quotient will shew the Rate of Interest *per Cent. per An.*

Note, We take a month for the $\frac{1}{12}$ part of a year, and in this Question the time given, be it months or days must be reduced to years and Decimal parts:

For

The amount	270.9
Sum first given	252.0
The Remainder	18.9

Is the Interest for the time sought: This divided by 252, the Quotient is .075.

Now the time sought being months, I find in the former Table the Interest of one Pound for one month at 6 *per* Cent. (*viz.* .005) by which I divide the former Quotient (*viz.* .075;) the last Quotient is 15, the number of months sought.

To work this by the Instrument, find the Interest as above, and then the proportion is,

1. *As* the Sum due upon B, is to 1 upon A,

So is the Interest thereof upon B, to a fourth term upon A.

2. *As* the Tabular Number (found as above) upon B, is to 1 upon A;

So is the fourth term upon B, to the time sought upon A.

Thus in the last Example, the Interest was found to be 18.9:

Therefore,

Therefore,

Set 252 upon B, to 1 upon A, then against 18.9 upon B, is .075 upon A.

Again,

Set .005 (the Interest of one Pound for one month) upon B, to 1 upon A, then against .075 upon B, is 15 (the months sought) upon A.

Quest. V.

A Sum of Money proposed, and also the Interest due for the same for any time given, to find at what Rate of Interest it became due.

Rule.

Multiply the Interest by 100, and divide the Product by the Principal Multiplied by the time given, this done the Quotient will shew the Rate of Interest *per Cent. per An.*

Note, We take a month for the $\frac{1}{12}$ part of a year, and in this Question the time given, be it months or days must be reduced to years and Decimal parts:

For

For which say,

As 12 to 1,

So is any number of months to the years and parts: And,

As 365 to 1,

So is any number of days to the years and parts: Now to the Question,

Example: *If* 252 l. *being forborn* 15 *months did gain* 18 l. 18 s. (*or* 18.9.) *What Rate of Interest was it accompted at?*

The Interest (*viz.*) 18.9 Multiplied by 100 is 1890: And the principal 252 Multiplied by the time, *viz.* 1.25 is 315, by which divide the former Product, (*viz.*) 1890, the Quotient will be 6, which is the Rate of Interest sought.

Quest. VI.

A Sum of Money due at any time to come, at any Rate of Interest per Cent. per An. *to find the present worth.*

Rule.

Divide the Sum given by the Amount of one Pound in the time, and at the Rate proposed, the Quotient will be the present worth. Ex-

Example: *If* 270.9 l. *be due at the end of 15 months to come, What is it worth in ready Money discompting Interest at* 6 per Cent. per An.

The amount of one Pound in any time may be found by the third Quest. In 15 months it will be 1.075, by which divide 270.9, (the Sum proposed) the Quotient will be 252*l.* and so much present Money is worth 270.9*l.* due at the end of 15 months to come, for 252*l.* with the Interest thereof for 15 months will Amount to 270.9, as appears by the fourth Quest.

Of Annuities at Simple Interest.

Probl. II.

To find the Amount of any Annuity for any time given, and at any Rate of Simple Interest.

A General Rule.

1. FInd the Interest of the Annuity for half the number of years, half years or quarters, that the Annuity is to continue:

2. Mul-

2. Multiply the Interest thus found by the Number of years, half years or quarters, less by 1, and to this Product add the Sum of the Annual, half yearly, or quarterly payments, the Sum will be the true amount of the Annuity.

Example: What is the Amount of an Annuity of 100l. in 8 years?

The Interest of a 100*l.* for half the time, *viz.* 4 years, is 24*l.* this Multiplied by the number of years less by 1, (*viz.*) 7, the Product will be 168, to which add the Sum of the Annual payments, *viz.* 800, the Sum will be 968*l.* the amount sought.

Probl. III.

To find the present worth of any Annuity for any given time, at any Rate, accompting Simple Interest.

The Rule, or proportion is,

AS the amount of 1 *l.* in any time is to 1*l.* *So* is the amount of any Annuity, to the present worth.

Therefore,

Therefore,

Divide the amount of the Annuity by the amount of one Pound in the time given, the Quotient is the present worth.

Example: *What is the present worth of an Annuity of* 100 l. *to continue* 8 *years?*

The amount of 100 *l.* Annuity for 8 years by the last Probl. is found to be 968 *l.* and the amount of one Pound in 8 years, will be found (by the second Quest.) to be 1.48.

Now if 968 (the amount of the Annuity) be divided by 1.48, the Quotient is 654.054, and so much present Money is equal in value to an Annuity of 100 *l.* for 8 years, for if this 654.054 be put out at Interest, it will in 8 years amount to 968 *l.* as may be found by the Rule given in Quest. 3.

Of Compound Interest.

IN Compound Interest, the respective amounts for each respective year are so many Geometrical proportional Numbers. Thus, if 100 *l.* be put out to Interest at 6 *per Cent. per An.* there will be due at the

2. Multiply the Interest thus found by the Number of years, half years or quarters, less by 1, and to this Product add the Sum of the Annual, half yearly, or quarterly payments, the Sum will be the true amount of the Annuity.

Example: *What is the Amount of an Annuity of 100l. in 8 years?*

The Interest of a 100*l.* for half the time viz. 4 years, is 24*l.* this Multiplied by the number of years less by 1, (*viz.*) 7, the Product will be 168, to which add the Sum of the Annual payments, *viz.* 800, the Sum will be 968*l.* the amount sought.

Probl. III.

To find the present worth of any Annuity for any given time, at any Rate, accompting Simple Interest.

The Rule, or proportion is,

As the amount of 1 *l.* in any time is to 1*l.* *So* is the amount of any Annuity, to the present worth.

Therefore,

Therefore,

Divide the amount of the Annuity by the amount of one Pound in the time given, the Quotient is the present worth.

Example: *What is the present worth of an Annuity of* 100 l. *to continue* 8 *years?*

The amount of 100*l.* Annuity for 8 years by the last Probl. is found to be 968*l.* and the amount of one Pound in 8 years, will be found (by the second Quest.) to be 1.48. Now if 968 (the amount of the Annuity) be divided by 1.48, the Quotient is 654.054, and so much present Money is equal in value to an Annuity of 100*l.* for 8 years, for if this 654.054 be put out at Interest, it will in 8 years amount to 968*l.* as may be found by the Rule given in Quest. 3.

Of Compound Interest.

IN Compound Interest, the respective amounts for each respective year are so many Geometrical proportional Numbers. Thus, if 100*l.* be put out to Interest at 6 *per Cent. per An.* there will be due at the

the end of the first year 106 *l.* which 106 is now made a Principal, and at the end of the second year will Amount to 112.36, and this being made a Principal, will at the end of the third year be increased to be 119.1016, now these four Numbers, *viz.* 100, 106, 112.36, and 119.1016, are four Geometrical proportional numbers:

For,

As 100 to 106, (for the first year)
So is 106 to 112.36. (for the second year)

Again,

As 106 to 112.36,
So is 112.36 to 119.1016, for the third year, *&c.*

Probl. IV.

Any Sum of Money being propounded, to find the amount thereof in any time, at any Rate of Compound Interest.

Example

Example: *What is the Amount of* 100 l. *being forborn 5 years at* 6 per Cent. per An. *Compound Interest?*

SEt 100 upon B, to 106 (the first years amount) upon A; then against 106 upon B, you have 112.36 upon A, the Amount in two years.

In like manner.

2. Against 112.36 upon B, is 119.1016 upon A, the amount in three years:

Again,

3. Against 119.1016 upon B, is 126.247 upon A, the amount in four years.

Lastly,

Against 126.247 upon B, you have 133.822 upon A, which is the amount in 5 years, and the Answer to the Quest.

See another Example:

What is the amount of 60 l. *being forbo[rn] three years at* 6 per Cent. per An. *Co[m]pound Interest?*

1. Set 100 upon B, to 106 upon A then against 60 upon B, is 63.6 upon A the amount in one year.

2. Against 63.6 upon B, is 67.416 upon A, the amount in two years.

3. Against 67.416 upon B, you hav[e] 71.46 upon A: And so much will 60 [l.] amount unto being forborn three years and thus at once setting the Rule, you ma[y] find the amount to as many years as yo[u] please.

Probl. V.

A Sum of Money being due at any time t[o] come, to find what it is worth in read[y] Money at any Rate of Interest?

Example:

Example: *What is the present worth of 133.8221. due at the end of 5 years to come, at 6 per Cent. per An. Compound Interest?*

THis is but the Inverse of the first Example in the last Probl. Therefore if you set the Rule as is there directed, you may read the proportion back again: For the respective amounts found upon A, in that Example will point you to the respective present worths at the end of each respective year.

Thus,

Set 106 upon A, to 100 upon B; then against 133.822 upon A, is 126.247 upon B: The present worth of 100*l.* at the end of the first year.

Also,

Against 126.247 upon A, you have a 119.1016 upon B, the present worth at the end of the second year.

Again,

Again,

Seek 119.1016 upon A, against it you have 112.36 upon B, the present worth at the end of the third year.

In like manner,

Against 112.36 upon A, is 106 upon B, the present worth at the end of the fourth year.

Lastly,

Against 106 upon A, you have 100 upon B, which is the present worth of 133.822*l.* at the end of five years which was required. These two Questions prove each other; for as by Probl. 4. it appears that 100*l.* will in five years time amount to 133.822: So by Probl. 5. 'tis as evident that 133.822*l.* due at the end of five years to come, is worth but 100*l.* ready Money.

Probl. VI.

A yearly Rent or Annuity being forborn a certain number of years, to find what the arrearages thereof will amount unto at any Rate propounded.

Rule.

Rule.

1. FInd a Sum (or principal) whose Interest is equal to the Annuity or yearly Rent.

2. Find by the fourth Prob. the amount of that Sum in the time given: This done, subtract the principal first found from the amount, the remainder will be the answer.

Example: *A Rent or Annuity of* 9 l. per An. *being forborn* 12 *years, What will the arrearages thereof amount unto accompting Interest upon Interest at* 6 per Cent?

To find a principal whose Interest is 9 *l.*

Say,

As 6 to 100,
So is 9 to 150, the principal sought.

The amount of 150 *l.* in 12 years, will be found by the fourth Probl. to be 301.828, from which subtract (the principal first found, *viz.*) 150, the remainder will be 151.828, the Sum of the arrearages sought.

Probl.

Probl. VII.

A yearly Rent or Annuity being propounded, to find what it is worth in ready Money?

Rule.

FIrst, find (by the last Probl.) what the arrearages thereof will amount unto at the end of the term propounded: Then (by the fifth Probl.) find the present worth of those arrearages; the present worth thus found is the value of the Annuity or yearly Rent sought.

Example: *Suppose a Rent of* 9 l. per An. *to continue* 12 *years, What sum of Money may be given for this Rent, allowing the buyer* 6 per Cent. *Compound Interest?*

BY the last Question the arrearages of a Rent of 9*l. per An.* being forborn 12 years, were found to be 151.828*l.*

And the present worth of 151.828, due at the end of 12 years to come will be found (by the fifth Probl.) to be 75.443, and so much may be given for a Rent of 9*l. per An.* to continue 12 years.

But

But suppose the term of the Rent or Annuity begins not 'till after the expiration of many years to come, in such case find what the arrearages forborn for all that time are worth in ready Money, for that is the Answer.

For Instance.

Suppose in the last Example, the Annuity of 9 l. for 12 years were not to begin 'till after the expiration of 6 years: I here seek what the arrearages (*viz.* 151.828) being forborn 18 years are worth in ready Money, and by the 5th. Problem I find it will be 53.185 l. which is the Answer: So a yearly Rent or Annuity of 9 *l. per An.* to begin 6 years hence, and continue 12 years, is worth but 53.185, in ready Money.

Probl. VIII.

A Sum of Money being propounded, to find what Annuity (to continue any Number of years, and at any Rate proposed) that Sum will buy.

Rule.

TAke any Annuity at pleasure, and find the value thereof in ready Money: This done the proportion is,

As

As the present worth found is to Annuity taken,

So is the Sum given to the Annuity soug

Example : *What Annuity to continue* 12 *ye will* 300*l. Purchase, allowing the buyer* per Cent. *Compound Interest ?*

By the 7th. Problem I find that 75.4 will Purchase 9 *l. per An.* to continue years.

Therefore,

Set 75.443 upon B, to 9 upon A; th against 300 upon B, is 35.776 upon that is, 35 *l.* 15 *s.* 6 *d.* and so much Annu to continue 12 years is worth 300*l.*

Probl. IX.

There is a free hold Estate of the yearly val of 78*l. What Sum of Money is this Esta worth allowing the buyer* 6 per Cent. p An. *Compound Interest for his Money?*

The Rule or Proportion is,

As the Annual, half yearly or quarterly Interest of 1 *l.* is to 1 *l.*

So is the Annual, half yearly or quarterly Rent, to the Sum sought.

The Interest of 1 *l.* at 6 *per Cent.* Compound Interest

For 1	year	is	.06	
	half year		.02956	
	quarter		.01467	

Now to Answer the Question.

Set .06 upon B to 1 upon A, then against 78 upon B is 1300 upon A, which is the value of the Estate propounded; and for the same reason I find without moving the Rule, that a freehold Estate

of	90	Pounds	1500	Pounds.
	120	*per An.*	2000	
	150	is worth	2500	

But suppose the Rent of the Former's Estate, (*viz.* 78 *l.*) were payable *Quarterly*, (*viz.* 19.5 *l. per* Quarter:) *What is it then worth*, allowing the purchaser 6 *per Cent.* as before?

K Set

Set .01467 (the Interest of 1 *l.* for Quarter of a year) upon A, to 1 upon B then against 19.5 (the Quarters Rent) upon A, you have 1329.244 upon B, that is 1329 *l.* 4 *s.* 10½ *d.* the Answer, which is 29 *l.* 4 *s.* 10½ *d.* more than the former; that being accounted by yearly, this by Quarterly Payments.

Probl. X.

A Sum of Money propounded, to find the Annual Rent of a freehold Estate that such Sum will purchase, at a given Rate of Compound Interest.

THis is the Converse of the last, and therefore the proportion is:

As 1 to the Annual Interest,

So is the Sum propounded to the Annual Rent.

Example: *Suppose I would lay out* 3650 *upon a freehold Estate, so as to have* per Cent. *for my Money, What must the Annual Rent be?*

Set 1 upon A to .06 upon B; then against 3650 upon A, you have 219 upon B: The Answer is, 219 *l.* *per An.*

Prob

Probl. XI.

[The] Annual Rent of a freehold Estate being [give]n, and also the Sum of Money which [i]s paid for the same, to find what rate [of] Compound Interest the Purchaser shall have [fo]r his Money.

The proportion is,

[A]s the Sum given is to 1,
So is the Annual Rent to the rate of [Intere]st.

[Exam]ple: *There is* 1300 *l. given for a free-[hold] Estate, whose Annual Rent is* 78 l. *[Wh]at rate of Interest has the purchaser for [his] Money?*

[Set] 1300 upon A to 1 upon B; then a-[gainst] 78 upon A is .06 upon B: So the Pur-[chase]r shall have 6 *per Cent.* for his Money.

Lastly,

[If] it be demanded, *How many years Pur-[chase] any freehold Estate is worth at any rate [of Com]pound Interest?*

K 2 *The*

The Proportion is,

As the Rate of Interest is to 1,
So is 1 to the Answer: Example, a
per Cent.

Set .05 upon B to 1 upon A; then aga
1 upon B, is 20 upon A; so at 5 *per C*
it is worth 20 years Purchase.

At 6 *per Cent.* It is worth but 16
years Purchase.

For,

As .06 upon B to 1 upon A,
So is 1 upon B to 16.66 upon A, tha
16 years 8 months and somewhat more.

The Converse of this is *to find by*
Number of years Purchase, what Rate
Interest the buyer hath for his Money.

Say,

As the Number of years Purchase
to 1.
So is 1 to the rate of Interest.

Exampl

Example: A Free-hold Estate is bought at 20 years Purchase; What rate of Interest hath the Purchaser for his Money?

Set 20 upon A to 1 upon B, then against 1 upon A, is .05 upon B; that is, 5 *per Cent. per An.*

FINIS.

AN APPENDIX:

CONTAINING THE Description and Use OF ANOTHER NEW RULE, Very Useful in GAUGING OF WORTS:

Shewing by Inspection how many Gallons and Hundred Parts any small Tub (or such like open Vessel) will contain at one Inch deep (without knowing the Diameter.) And resolving many other Questions in the Mensuration of Solids, as Timber, Stone, Brickwork, *&c.* And Superficies, as Board, Paving, Cieling, Wainscoting, Flooring and Tyling. With a Table of the Area's of Circles and Contents of Cylinders in Ale Gallons: Calculated to every tenth Part of an Inch, from 12 to 144 Inches Diameter.

Printed by *J. Playford*, 1683.

APPENDIX.

THE Directions and Examples in the foregoing Tract, are so plain and intelligible, that I presume it will not be very difficult for any Person (who hath but carefully perused them) to find the Content of any Vessel whether it be regular or irregular, and also to resolve all other necessary Questions relating to the Art of Gauging.

But for as much as it is absolutely necessary, and is now expected of every Gauger that (besides his keeping of a stock) he Gauge and take an account of the Victualers worts, I have Composed a very useful and portable Instrument, which will render this work both facile and easie, and perform it with great Expedition.

Description of the Instrument.

The Instrument consists of three Parts, one fixt (which is 12 Inches long) the other

two being moveable may be drawn out 'ti the whole be 36 Inches long.

1. Upon one ſide of the Rule you hav two double Lines of Numbers (A and B) t ſlide one by another, by theſe is perform' Multiplication, Diviſion, Rule of Three, &c as by the directions in the third Chapter o the Book.

Moreover upon this ſame ſide of the Rul you have a Line of double Numbers to ſlid by a Line of Segments: By which and th two former you may find the Ullage of of a Cask, as in the ninth Chapter afore going.

2. Upon the other ſide of the Rule (op poſite to this) you have a Line of doubl Numbers (C) to ſlide againſt a Line of ſingl Numbers (D), theſe ſhew the Square-Roo by Inſpection, and the Area's of Circles a in pages 54 and 70 of the Book.

Upon this ſide you have alſo a Line o ſingle Numbers (D), to ſlide by a Line o Triple Numbers (E), and theſe ſhew th Cube Root by Inſpection, as in page 56 aforegoing.

3. Upon another ſide of the Rule you have a Line of Inches, and againſt it three other Lines by which you may find the mean Diameter of any Cask, as in page 143 of the Book.

These

These Lines already mention'd are the same which are upon the Long Rule, whose use we have explain'd in the foregoing Tract: And all the Problems which are there resolved by that Instrument may (by the same directions) be also resolved by this little Rule, though not so near the truth, that being three times the length of this.

Now the Lines which are design'd to shew the quantity of Wort in any small Tub, *&c.* are placed on the inside of the two sliding pieces, and these are so plain and obvious that its needless to give any Discription of them: I shall therefore proceed to shew their use, which is to find how many Ale Gallons, and Hundred parts of a Gallon, any small Tub or such like open Vessel (from 12 to 36 Inches Diameter) will contain at one Inch deep; to perform which, observe the following Directions.

☞ Let the sliding piece C D, be pin'd fast at the end towards the Right-hand; then holding the Rule Parallel, and as near to the Surface of the Liquor as you can, draw out the other sliding piece 'till the two ends touch any two opposite sides of the Tub or Vessel, this done look what divisions (both upon

two being moveable may be drawn out 'ti
the whole be 36 Inches long.

1. Upon one side of the Rule you hav
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Multiplication, Division, Rule of Three, &
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going.

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posite to this) you have a Line of doubl
Numbers (C) to slide against a Line of singl
Numbers (D), these shew the Square-Roo
by Inspection, and the Area's of Circles a
in pages 54 and 70 of the Book.

Upon this side you have also a Line o
single Numbers (D), to slide by a Line o
Triple Numbers (E), and these shew th
Cube Root by Inspection, as in page 5
aforegoing.

3. Upon another side of the Rule you
have a Line of Inches, and against it three
other Lines by which you may find the
mean Diameter of any Cask, as in page 143
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☞ Let the sliding piece C D, be pin'd fast at the end towards the Right-hand; then holding the Rule Parallel, and as near to the Surface of the Liquor as you can, draw out the other sliding piece 'till the two ends touch any two opposite sides of the Tub or Vessel, this done look what divisions (both upon

upon the Line of Gallons and Line of Inches upon the sliding piece) are cut by the end of the Rule, for that point doth shew the Diameter of the Tub in Inches and tenth parts upon one Line, and upon the other how many Gallons and Hundred parts it will contain at one Inch deep.

Thus when the end of the Rule cuts 13.4 on the Line of Inches, it will also cut o Gallons 5 tenths on the Line of Gallons; in like manner, when it cuts 21 on the Inch Line it will at the same time cut 1.23 on the Line of Gallons; that is, 1 Gallon and .23 Hundred parts, and so much will a Tub of 21 Inches Diameter contain at one Inch deep. And thus you may draw out this piece to 24 Inches and an half, and then the end of the Rule will cut 1.673 on the Line of Gallons.

Now if the Diameter of the Tub be more than 24.5, pin this piece at 24.5, and then draw out the other sliding piece at the other end, where you will find that when the end of the Rule cuts 30 Inches, it will also cut 2.51 Gallons, and thus you may draw out this piece to 36 Inches, where you will find 3 Gallons, 6 tenths and more: *Note*, In all these cases 'tis the Area only which is sought, the Inches do also

to shew the Diameter, but this is to make the other more plain.

Now the Tubs or Vessels which Victualers do commonly make use of in cooling their Worts, and working their Ale, are either Cylindrical or Conical, and in either of these the bases are Circular or Elliptical.

First of such as are Cylinders or near that form.

If the bases of a Cylindrical Tub be Circular, the Rule doth shew the Area or Content at one Inch deep by inspection, (as above) this Multiplied by the depth of the Liquor gives the Content.

For Instance.

Admit I come to a Tub and (by the Rule) find the Area to be 1 Gallon 4 tenths, and the depth of the Wort 7 Inches and an half;

Multiply the Area ———	1.4
by the depth, *viz.* ———	7.5
	70
	98
The Product is ———	10.50

That is, 10 Gallons and an half, the Content sought.

But

But this Content may be found with the Pen, for having the Area and the dep you may Multiply the one by the othe by the Rule: Thus,

Set 1 upon B, to 1.4 the Area upon then against 7.5 the depth upon B, y have 10.5 upon A, the Content as before

If the Veſſel be Elliptical, (as many which are uſed inſtead of Coolers) ta the Croſs Diameters in the middle of t depth, and Multiply the one by the oth then divide the Product by 359, the Qu tient is the Area or Content in Ale Gall at one Inch deep.

Example.

Let the longeſt Diameter be 60 Inche and the ſhorteſt 40, theſe Multiplied giv 2400, and this divided by 359 the Qu tient is 6.68, the Content at one Inch deep

Or more readily by the Lines A and on the Inſtrument: Say,

As 359 is to one of the Diameters,
So is the other Diameter to the Area Content.

And by this Proportion the Area of t Ellipſis above mention'd will be found be 6.68: For,

As 359 upon B is to 40 upon A,
So is 60 upon B to 6.68 upon A.

This is the true way of finding the Area of an Ellipsis. But in small Elliptical Tubs you may find the Area with less trouble:

Thus,

Find (by drawing out the Rule) the Area of the longest Diameter, and in like manner the Area of the shortest Diameter, half the Sum of these two is the Area sought.

For Instance.

Suppose the Area of the longest Diameter be ————————	3.62
And the Area of the shortest ———	2.51
The Sum is ————————	6.13
The half is ————————	3.065

The Area required; which is very near the truth, for if you work by the former Rule you will find the true Area to be but 3.008.

Secondly

Secondly for Conical Vessels.

When the Diameters at top and bottom differ not above 4 Inches, you may find the Area in the middle of the depth by drawing out the Rule as above directed, and this Area thus found is very near a true mean for the whole Tub.

Example.

Let the Diameter at the bottom of a Conical Tub be 24 Inches, and the Diameter at the Top 28 Inches, in the middle of the depth of this Tub you will find (by the Rule) the Diameter 26 Inches, and the Area 1.88 Gallons.

And if the Diameters at top and bottom differ 6 or 8 Inches, a mean Area found as above will be near enough for finding the whole Content, nay if the Tub be but almost full it will suffice; but when such Tubs are less than half full, you may find the quantity of Liquor more exactly: Thus,

Take (when the Tub is empty) the Area of the bottom, which set down in your Book, then when ever you find Wort in this Tub (be it more or less) take the Area

of

of the Liquors Surface, which add to the Area of the bottom, half this Sum is the mean Area in the middle of the depth of the Liquor, this Multiplied by the depth gives the Content very near the truth, (never too little.)

Example.

Suppose I come to a Conical Tub, the Area of whose bottom I have in my Book, (let it be 1 Gallon and 7 tenths) and I find the Area of the Liquors Surface to be 2 Gallons 6 tenths, and the depth 12 Inch. How many Gallons are contain'd in this Tub?

Area at the bottom ———	1.7
Area of Liquors Surface ———	2.6
Sum is ———	4.3
The half is ———	2.15
The depth is ———	12
	430
	215
The Content is ———	25.80

Which

Which is but a Pint and an half too much, for the true Content is but 25.6, the error is inconsiderable.

And for such Conical Tubs (or Tuns) whose Diameters are above 36 Inches, if they be near a Cylinder one mean Inch will be sufficient.

But for such as are much Conical and great, you may find the whole Content by the Rules given in page 99 of the Book; and if you desire to Inch any such Tun, observe the directions in page 123.

There are yet another sort of Vessels which Victualers do frequently use to work their Ale in, and these are part of a But or Pipe set upon one head, the other being cut off.

Now the Content of these may be found by the directions in the 9th. Chapter.

Or thus,

Take the Diameter of the Bung, (or widest place) and also the Diameter of the bottom, (which is usually the Head) and then find a mean Diameter by the Scales upon the Rule, (or by the Table for that purpose in page 144;) for the mean Diameter thus found will give you the mean Inch,

[...]ch, which Multiplied by the depth gives [...] Content.

For Instance.

There is a Canary Pipe ſtanding upon [o]ne Head, the other being cut off above [1]2 Inches from the Bung; Let the Diameter of the Bung be 29 Inches, and the Diameter of the Head or bottom 23, the difference is 6; Now this Veſſel being taken for the Fruſtum of a Conoid, I ſeek the difference of Diameters, (*viz.* 6,) upon the Line of Inches, and againſt it in the Scale [fo]r a Conoid I find 3.2, (the ſame I alſo find by the Table) this added to 23 the Head Diameter is 26.2 the mean ſought, and for the Area of this the Rule gives 1.91 Gallons, which is the mean Inch for this Veſſel.

Note, If the Liquor in this Veſſel come up to the Bung, the mean Inch abovesaid being Multiplied by the wet Inches, gives the true Content of the Liquor, but when the Surface of the Liquor is beneath the Bung, it may give a Pint or two too much, and when it is above the Bung it will give as much too little, but this error being very ſmall the mean Inch found as above will

will ſuffice in moſt Caſes. If any deſire to be more exact, let them take (when the Veſſel is empty) a Diameter in the middle of every 4 or 6 Inches of the depth, and ſo Inch the Veſſel by the direction in page 123.

I have obſerved in ſeveral places they Cool their Worts in Braſs-pans whoſe Diameter is about 30 Inches, and depth 10 or 12 Inches, but theſe are commonly deeper in the middle by an Inch or two than at the ſide.

In ſuch Veſſels as theſe if you take (with the Rule) the Area of the Liquors Surface, and Multiply it by the depth taken within 3 or 4 Inches of the ſide, the Product will be the Content very near the truth.

And for round Bowls which are like the Segment of a Globe, if you Multiply the Area of the Liquors Surface by half the depth, it gives the Content near enough in Practice: But in ſuch Caſes as theſe, Experience will be your beſt Tutor.

But that I may not be wanting to the meaneſt Capacities; I have at the end of this Appendix inſerted a very uſeful Table, ſhewing the Area's of Circles and Contents of Cylinders in Ale Gallons, to all Diameters in Inches and tenths, from

12 to 144 Inches Diameter, and at any depth whatſoever.

The Table explain'd.

The two firſt pages (and ſo every two next ſucceeding) contains 10 Columns, in the firſt of which you have the Diameters of Circles beginning at 12, and continu'd down (in the firſt Column of each left hand page) in Inches and tenths to 144 Inches: The other 9 Columns are Numbered at the top 1, 2, 3, 4, 5, 6, 7, 8, 9 in the firſt of theſe you have the Area's of Circles at one Inch deep, to the ten thouſandth part of an Ale Gallon.

In the next Column under 2, is the Content of 2 Inches deep, under 3 you have the Content at 3 Inches deep, in the next at 4 Inches deep; in like manner under 5, is the Content at 5 Inches deep, and ſo on to 9 Inches deep, in the laſt Column under 9.

The Uſes of this Table are.

1. *To*

1. To find the Area of any Circle, the Diameter being given.

And this it doth by inspection, for in the Column under 1, you have the Area to any Diameter from 12 to 144: Thus, against this Diameter 43 in the first Column you have 5.1496 in the next Column, which is the Area sought, the like for any other.

2. To find the Content of any Cylindrical Tun, the Diameter and depth being given.

To effect this observe, when the depth is whole Inches only, and less than 10, you have the answer at once by inspection, for against the Diameter and under the depth is the Content sought.

Example.

Let the Diameter of a Cylindrical Tun be 58.5 Inches, and the depth 6 Inches: What is the Content?

Seek 58 in the first Column, and in the fifth Line under it against 5 tenths, and under 6 (the depth) you will find 57.19, which is the Content sought. In

In like manner in the same Line under 7 you have 66.72, the Content at 7 Inches deep.

Note, If this Tun were 70 Inches deep the same Number, *viz.* 66.72 gives the Content, removing the prick one place towards the Right-hand, and then it will be 667.2 Gallons.

And if the depth were but 7 tenth parts of an Inch, you must remove the prick one place towards the Left-hand, and then it will be 6.672.

Hence 'tis evident this Table being made to 9 Inches deep, will shew the Content at any other depth whatsoever.

Example.

There is a Tun in the form of a Cylinder, the Diameter is 61 Inches, and the depth 35.6 Inches: What is the Content?

Find 61 in the first Column, and in the Line against it, under 3 you have 31.09, which by removing the prick is 310.9 the Content of 30 Inches deep, set this down as in the Margin.

Again,

Again, in the same Line (against and) under 5 is 51.81, set this down und the former, then for the 6 tenths ta the Number under 6, (*viz.* 62.18) and moving the prick one place towards t Left-hand set it under the other, these b ing added together:

	30 ———	310.9
	5 ———	51.81
	0.6 ———	6.21
The Sum is ———	35.6 =	368.92

which is the Content sought: And afte the same manner you may find that a Tu of 61 Inches Diameter, and 28.5 Inche deep will contain 295.38 Gallons: See th work:

20 ———	207.3
8 ———	82.9
0.5 ———	5.18
28.5 =	295.38

What hath been done by the Table, may also be perform'd by the Rule.

For

For Instance.

In the first Example aforegoing, we find that a Tun whose Diameter is 58.5 Inches, and depth 6 Inches, will contain 57.19 Gallons.

By the Rule.

Set the Gauge-point to 6 the Tuns depth upon C, then against 58.5 the Diameter upon D, you have 57.19 upon C, the Content as before. And thus the Rule and the Table exactly agreeing (as they will always do except you mistake) the one is a Confirmation of the other.

In page 64 of the Book, 'tis said the Circumference of a Circle whose Diameter is Unity is 3.141592, and the Area of such a Circle is .785398, the Square Root of this is .886221, which is the side of a Square equal to the Circle: Note also, that when the Diameter is 1, the side of the greatest Square that can be inscrib'd is .707106: So that if the Diameter of a Circle be 1:

The	Circumference	is	3.141592
	Square equal		.886221
	Sq. Inscribed		.707106
	Area		.785398

And by these Numbers I also find that when the Circumference of a Circle be 1:

$$\text{The}\left\{\begin{array}{l}\text{Diameter}\\ \text{Sq. equal}\\ \text{Sq. Inſcrib'd}\\ \text{Area ———}\end{array}\right\}\begin{array}{c}\text{will}\\ \text{be}\end{array}\left\{\begin{array}{l}.318309\\ .282092\\ .225078\\ .079578\end{array}\right\}$$

Note further, when the Area is 1:

$$\text{The}\left\{\begin{array}{l}\text{Diameter ——}\\ \text{Circumference}\end{array}\right\}\text{is}\left\{\begin{array}{l}1.128378\\ 4.54491\end{array}\right\}$$

[See Figure 24.]

As a Conſequence of which take the following Problems, which you may reſolve either by the Pen or Inſtrument.

Probl. I.

The Diameter of a Circle being given, to find the Circumference.

Rule.

If the Diameter of any Circle be

$$\left.\begin{array}{l}\text{Multiplied}\\ \text{Divided—}\end{array}\right\}\text{by}\left\{\begin{array}{l}3.141592\\ .318309\end{array}\right\}\begin{array}{l}\text{Prod.}\\ \text{Quot.}\end{array}\Big\}\text{ is}$$

the Circumference.

Example.

Let the Diameter be 30: Therefore [by the Lines A and B ſay,]

$$\textit{As}\left\{\begin{array}{l}1\text{ to }3.141592\\ .318310\text{ to }1\end{array}\right\}\textit{So}\text{ is 30 to }94.24776$$

the Circumference ſought.

Probl.

Probl. II.

The Circumference of a Circle being given, to find the Diameter.

Rule.

If the Circumference of any Circle be Multiplied / Divided by .318309 / 3.141592 Prod. / Quot. is the Diameter required.

$$\left.\begin{array}{l}\text{Multiplied}\\\text{Divided}\end{array}\right\}\text{ by }\left\{\begin{array}{r}.318309\\3.141592\end{array}\right\}\begin{array}{l}\text{Prod.}\\\text{Quot.}\end{array}\Big\}\text{ is the}$$

Diameter required.

Example.

The Circumference of a Circle is 94.24776: Therefore [by the Lines A and B, say,]

$$\text{As}\left\{\begin{array}{l}1\text{ to }.318309\\3.141592\text{ to }1\end{array}\right\}\textit{So}\text{ is }94.2776\text{ to }30$$

the Diameter sought.

You have both these Problems in the Book, I insert them in this place only for method sake.

$$\text{The}\left\{\begin{array}{l}\text{Diameter}\\ \text{Sq. equal}\\ \text{Sq. Inscrib'd}\\ \text{Area} \text{ ——}\end{array}\right\}\begin{array}{c}\text{will}\\ \text{be}\end{array}\left\{\begin{array}{l}.318309\\ .282092\\ .225078\\ .079578\end{array}\right\}$$

Note further, when the Area is 1:

$$\text{The}\left\{\begin{array}{l}\text{Diameter —-}\\ \text{Circumference}\end{array}\right\}\text{ is }\left\{\begin{array}{l}1.128378\\ 4.54491\end{array}\right\}$$

[See Figure 24.]

As a Consequence of which take the following Problems, which you may resolve either by the Pen or Instrument.

Probl. I.

The Diameter of a Circle being given, to find the Circumference.

Rule.

If the Diameter of any Circle be

$$\left.\begin{array}{l}\text{Multiplied}\\ \text{Divided—}\end{array}\right\}\text{ by }\left\{\begin{array}{l}3.141592\\ .318309\end{array}\right\}\left.\begin{array}{l}\text{Prod.}\\ \text{Quot.}\end{array}\right\}\text{ is}$$

the Circumference.

Example.

Let the Diameter be 30: Therefore [by the Lines A and B say,]

$$\textit{As}\left\{\begin{array}{l}1 \text{ to } 3.141592\\ .3\ 830;\ \text{to } 1\end{array}\right\}\textit{So} \text{ is } 30 \text{ to } 94.24776$$

the Circumference sought.

Probl.

Probl. II.

The Circumference of a Circle being given, to find the Diameter.

Rule.

If the Circumference of any Circle be Multiplied } by { .318309 } Prod. } is the Divided } by { 3.141592 } Quot. } is the Diameter required.

Example.

The Circumference of a Circle is 94.24776: Therefore [by the Lines A and B, say,]

As { 1 to .318309 } So is 94.2776 to 30
As { 3.141592 to 1 } So is 94.2776 to 30

the Diameter sought.

You have both these Problems in the Book, I insert them in this place only for method sake.

Probl. III.

The Diameter of a Circle being given, to [find] *the side of a Square equal to the Circle.*

Rule.

If the Diameter of any Circle be

$$\left.\begin{array}{l}\text{Multiplied}\\ \text{Divided}\end{array}\right\}\text{by}\left\{\begin{array}{l}.886221\\ 1.128378\end{array}\right\}\left.\begin{array}{l}\text{Prod.}\\ \text{Quot.}\end{array}\right\}\text{is}$$

side of the Square sought.

Example.

The Diameter is 30: Therefore [the Lines A and B, say,]

$$\textit{As}\left\{\begin{array}{l}1\text{ to }.886221\\ 1.128378\text{ to }1\end{array}\right\}\textit{So}\text{ is }30\text{ to }26.5866$$

which is the side required.

Probl. IV.

The side of any Square being given, to find the Diameter of a Circle whose Area shall be equal to the Square given.

Rule.

If the side of any Square be

Multiplied } by { 1.128378 } Prod. } is the
Divided } by { .886221 } Quot. } is the

Diameter sought.

Example.

The side of a Square is 26.58663: Therefore [by the Lines A and B, say,]

As { 1 to 1.128378 / .886221 to 1 } *So* is 26.58663 to 30

the Diameter sought.

Probl. V.

The Circumference of a Circle given, to fi[nd] the side of a Square equal to the Area [of] the Circle.

Rule.

If the Circumference of any Circle be

$$\left.\begin{array}{l}\text{Multiplied}\\ \text{Divided}\end{array}\right\} \text{by} \left\{\begin{array}{l}.282092\\ 3.54492\end{array}\right\} \left.\begin{array}{l}\text{Prod.}\\ \text{Quot.}\end{array}\right\} \text{is the}$$

side of the Square sought.

Example.

The Circumference is 94.24776: There-fore [by the Lines A and B, say,]

$$\textit{As} \left\{\begin{array}{l}1 \text{ to } .282092\\ 3.54492 \text{ to } 1\end{array}\right\} \textit{So} \text{ is } 94.24776 \text{ t[o]}$$

26.58663 the side sought.

Probl[.]

Probl. VI.

The side of a Square given, to find the Circumference of a Circle whose Area is equal to the given Square.

Rule.

If the side of any Square be

$$\left.\begin{matrix}\text{Multiplied}\\ \text{Divided}\end{matrix}\right\}\text{by}\left\{\begin{matrix}3.54492\\ .282092\end{matrix}\right\}\begin{matrix}\text{Prod.}\\ \text{Quot.}\end{matrix}\Big\}\text{ is the}$$

Circumference sought.

Example.

The side of a Square is 26.58663 : Therefore [by the Lines A and B, say,]

$$\textit{As}\left\{\begin{matrix}1 \text{ to } 3.54492\\ .282092 \text{ to } 1\end{matrix}\right\}\textit{So}\text{ is } 26.58663 \text{ to}$$

94.24776 the Circumference sought.

Probl. VII.

The Diameter of a Circle given, to find the ſid
of the greateſt Square Inſcribed.

Rule.

If the Diameter of any Circle be

$$\left.\begin{array}{l}\text{Multiplied}\\ \text{Divided}\end{array}\right\}\text{by}\left\{\begin{array}{l}.707106\\ 1.41421\end{array}\right\}\begin{array}{l}\text{Prod.}\\ \text{Quot.}\end{array}\Big\}\ \text{is th}$$

ſide required.

Example.

The Diameter is 30: Therefore [by the Lines A and B, ſay,]

$$\textit{As}\left\{\begin{array}{l}1 \text{ to } .707106\\ 1.41421 \text{ to } 1\end{array}\right\}\textit{So}\text{ is } 30 \text{ to } 21.21318$$

the ſide ſought.

Prob.

Probl. VIII.

The ſide of a Square given, to find the Diameter of a Circle that ſhall circumſcribe the Square.

Rule.

If the ſide of any Square be

$$\left.\begin{array}{l}\text{Multiplied}\\ \text{Divided}\end{array}\right\}\text{by}\left\{\begin{array}{l}1.41421\\ .707106\end{array}\right\}\left\{\begin{array}{l}\text{Prod.}\\ \text{Quot.}\end{array}\right\}\text{ is the}$$

Diameter ſought.

Example.

The ſide is 21.21318: Therefore [by the Lines A and B, ſay,]

$$\mathit{As}\left\{\begin{array}{l}1 \text{ to } 1.41421\\ .707106 \text{ to } .1\end{array}\right\}\mathit{So}\text{ is } 21.21318 \text{ to } 30,$$

the Diameter ſought.

Probl. IX.

The Circumference of a Circle being given, t find the ſide of the greateſt Square Inſcrib'd

Rule.

If the Circumference of any Circle be

$$\left.\begin{array}{l}\text{Multiplied}\\ \text{Divided}\end{array}\right\}\text{by}\left\{\begin{array}{l}.225079\\ 4.4429\end{array}\right\}\left\{\begin{array}{l}\text{Prod.}\\ \text{Quot.}\end{array}\right\}\text{ is the}$$

ſide ſought.

Example.

The Circumference is 94.24776: Therefore [by the Lines A and B, ſay,]

$$\textit{As}\left\{\begin{array}{l}1 \text{ to } .225079\\ 4.4429 \text{ to } 1\end{array}\right\}\textit{ So} \text{ is } 94.24776 \text{ to}$$

21.21318, the ſide required.

Probl. X.

The side of a Square given, to find the Circumference of a Circle that shall Circumscribe the Square.

Rule.

If the side of any Square be

Multiplied { by { 4.4429 } Prod. } is the
Divided { by { .225079 } Quot. } is the

Circumference sought.

Example.

The side is 21.21318: Therefore [by the Lines A and B, say,]

As { 1 to 4.4429 / .225079 to 1 } *So* is 21.21318 to

94.24776, the Circumference required.

Probl.

Probl. XI.

The Diameter of a Circle given, to find the Area.

Rule.

If the Square of the Diameter of any Circle be

$$\left.\begin{array}{l}\text{Multiplied}\\ \text{Divided}\end{array}\right\}\text{by}\left\{\begin{array}{l}.785398\\ 1.27324\end{array}\right\}\left.\begin{array}{l}\text{Prod.}\\ \text{Quot.}\end{array}\right\}\text{is the}$$

Area sought.

Example.

The Diameter is 30, its Square is 900: Therefore,

$$\textit{As}\left\{\begin{array}{l}1 \text{ to } .785398\\ 1.27324 \text{ to } 1\end{array}\right\}\textit{So}\text{ is } 900 \text{ to } 706.8582$$

the Area required: Or, by the Lines D and C, as in page 65.

Probl. XII.

The Area of a Circle given, to find the Diameter.

Rule.

If the Area of any Circle be

$$\left.\begin{array}{l}\text{Multiplied}\\\text{Divided}\end{array}\right\}\text{by}\left\{\begin{array}{l}1.27324\\.785398\end{array}\right\}\begin{array}{l}\text{Prod.}\\\text{Quot.}\end{array}\Big\}\text{ is the}$$

Square of the Diameter, whose Square Root is the Diameter sought.

Example.

The Area is 706.8582: Therefore,

$$\text{As}\left\{\begin{array}{l}1\text{ to }1.27324\\.785398\text{ to }1\end{array}\right\}\textit{So}\text{ is }706.8582\text{ to }900,$$

whose Square Root is 30, the Diameter required: Or, by the Lines D and C, as in page 66.

Probl.

Probl. XIII.

The Circumference of a Circle given, to find the Area.

Rule.

If the Square of the Circumference of any Circle be

$$\left.\begin{matrix}\text{Multiplied}\\ \text{Divided}\end{matrix}\right\}\text{by}\left\{\begin{matrix}.079578\\ 12.56636\end{matrix}\right\}\left\{\begin{matrix}\text{Prod.}\\ \text{Quot.}\end{matrix}\right\}\text{is the}$$

Area sought.

Example.

The Circumference is 94.24776, its Square is 8882.839: Therefore,

$$\textit{As}\left\{\begin{matrix}1 \text{ to } .079578\\ 12.56636 \text{ to } 1\end{matrix}\right\}\textit{So}\text{ is } 8882.839 \text{ to}$$

706.8582, the Area required.

Or,

As 1 upon D, to .079578 upon C,
So is any Circumference upon D, to the Area upon C.

Probl.

Probl. XIV.

The Area of a Circle given, to find the Circumference.

Rule.

If the Area of any Circle be

$$\left.\begin{array}{l}\text{Multiplied}\\ \text{Divided}\end{array}\right\}\text{by}\left\{\begin{array}{l}12.56636\\ .079578\end{array}\right\}\begin{array}{l}\text{Prod.}\\ \text{Quot.}\end{array}\Bigg\}\text{ is the}$$

Square of the Circle, whose Square Root is the Circumference sought.

Example.

The Area is 706.8582: Therefore,

$$\text{As}\left\{\begin{array}{l}1\text{ to }12.56636\\ .079578\text{ to }1\end{array}\right\}\textit{So}\text{ is }706.8582\text{ to}$$

8882.839, whose Square Root is 94.24776, the Circumference required.

Or,

Set .079578 upon C, to 1 upon D: Then against any Area upon C, you have the Circumference upon D.

Note,

Note, If the Diameter of one Circle b 1, and the Diameter of another Circle b 2, the Circumference of the first is equa to the Area of the Second, for each wi be 3.141592.

Note also, if the Circumference be 4,

The { Diameter and Area are equal, } *viz.* 1.27324.

And if the Diameter of a Circle be 4,

The { Circumference and Area are equal, } *viz.* 12.56636

By the Directions already given (in Chap. 6th. of the Book:) I suppose it will not be difficult to find the Content of any Solid; such as Timber, Stone and the like: But the Directions there given being either General, or such as relate particularly to Gauging: I shall here add such Problems as do more properly concern the Measuring of Timber, Stone and Brickwork.

The Common way of Measuring Round Timber, is to Girt the Tree in the middle with a Thread, and so find the Circumfe- rence:

ce in Inches, a fourth part of which is lgarly (but erroniously) taken for the t of a Square equal to the Circle, and on this supposition, the ordinary *Car-nters Rule* doth shew how many Inches in gth it will take to make a Foot.

For Instance.

Let there be a Round Tree whereof the Circumference is 48 Inches, one fourth of his is 12, the supposed Square equal, and this Case it will take 12 Inches in length make a Foot: So if the Tree here men-oned were 20 Foot long, it will contain o Feet of Timber.

But the side of a Square equal to a Circle, hose Circumference is 48, will be found (by the 5th. Problem aforegoing) to be 13.54.

And by the 13th. Problem the Area f the same Circle will be found to be 183.347, this Multiplied by 240, (the length in Inches) gives 44003.28, the Content in Square Inches, this divided by 1728, (the Number of Inches in a Solid Foot) the Quotient will be 25.46 the Con-tent in Feet, by this 'tis evident the Com-mon Rule gives the Content too little by 1 in 5.

The

Note, If the Diameter of one Circle be 1, and the Diameter of another Circle be 2, the Circumference of the first is equal to the Area of the Second, for each will be 3.141592.

Note also, if the Circumference be 4,

The $\left\{\begin{array}{l}\text{Diameter and}\\ \text{Area are equal,}\end{array}\right\}$ *viz.* 1.27324.

And if the Diameter of a Circle be 4,

The $\left\{\begin{array}{l}\text{Circumference and}\\ \text{Area are equal,}\end{array}\right\}$ *viz.* 12.56636

By the Directions already given (in Chap. 6th. of the Book:) I suppose it will not be difficult to find the Content of any Solid; such as Timber, Stone and the like: But the Directions there given being either General, or such as relate particularly to Ganging: I shall here add such Problems as do more properly concern the Measuring of Timber, Stone and Brickwork.

The Common way of Measuring Round Timber, is to Girt the Tree in the middle with a Thread, and so find the Circumference:

ence in Inches, a fourth part of which is vulgarly (but erroniously) taken for the side of a Square equal to the Circle, and upon this supposition, the ordinary *Carpenters Rule* doth shew how many Inches in length it will take to make a Foot.

For Instance.

Let there be a Round Tree whereof the Circumference is 48 Inches, one fourth of this is 12, the supposed Square equal, and in this Case it will take 12 Inches in length to make a Foot: So if the Tree here mentioned were 20 Foot long, it will contain 20 Feet of Timber.

But the side of a Square equal to a Circle, whose Circumference is 48, will be found (by the 5th. Problem aforegoing) to be 13.54.

And by the 13th. Problem the Area of the same Circle will be found to be 183.347, this Multiplied by 240, (the length in Inches) gives 44003.28, the Content in Square Inches, this divided by 1728, (the Number of Inches in a Solid Foot) the Quotient will be 25.46 the Content in Feet, by this 'tis evident the Common Rule gives the Content too little by 1 in 5.

The

The Use of the Instrument in Measuring of Timber and Stone.

Upon this little Rule the Foot is divide into 100 equal parts, and by a Foot th divided we take the Dimensions, (*viz.*) th length, Circumference and Diameters (o Round;) breadth and thickness,(of Square; and by some of these the Content of eithe Round or Square Timber may be readil found in Feet and Decimal Parts.

Of Round Timber.

Probl. XV.

The Circumference, Length and Content of any Round Tree, any two of these being given (in Feet measure) to find the other.

1. *By the Circumference and Length to find the Content.*

Rule.

(The Circumference of that Circle whose Area is 1 is 3.544.)

Therefore,

Therefore,

As 3.544 upon D, is to the Length upon C.

So is the Circumference upon D, to the Content upon C.

Example 1.

Suppose the Length of a Tree be 15 Feet, and the Circumference 3.8 Feet, What is the Content?

Set 3.544 upon D, to 15 (the Length) upon C, then against 3.8 the Circumference upon D, you have 18.25 upon C, that is, 18 Feet and a quarter, which is the Content sought.

Example 2.

Let the Length of a Tree be 26.5 Feet, and the Circumference 4.3, What is the Content?

Set 3.544 upon D, to 26.5 upon C, and against 4.3 upon D, is 39 upon C, which is the Content required.

Example 3.

Suppose the Circumference be 3 Feet, and the Length 10, What is the Content?

Set

Set 3.544 upon D, to 10 upon C, and against 3 upon D, is 7.16 upon C, and so many Feet will this Tree Contain.

And without moving the Rule you have the Content of all Round Trees, whose Length is 10 Feet, for what ever the Circumference be, against it upon D, you have the Content upon C: Thus (when the Length is 10 Feet) if the Circumference

be	3.5	the Content is	9.75	Feet.
	4.0		12.73	
	4.6		16.84	
	5.0		19.90	

2. *By the Circumference and Content to find the Length.*

Rule.

Set the Circumference upon D, to the Content upon C, then against 3.544 upon D, you have the Length upon C.

Example.

There is a Tree whose Circumference is 3 Feet, and the Content 7.16 Feet, what is the Length?

Set

Set 3 upon D, to 7.16 upon C, and against 3.544 upon D, is 10 upon C, which is the Length sought.

And if you set the Circumference 3 against any other Content, 3.544 will point you to the Length.

3. *By the Length and Content to find the Circumference.*

Rule.

Set the Length upon C, to 3.544 upon D, then against the Content upon C, you have the Circumference upon D.

Example.

There is a Tree whose Length is 10 Feet, and the Content 7.16, What is the Circumference?

As 10 upon C, is to 3.544 upon D: *So* is 7.16 upon C, to 3 upon D, which is the Circumference required.

Probl.

Probl. XVI.

The Circumference of a Round Tree being give in Inches, and the Length in Feet, to find th Content in Feet.

The Rule given in the firſt Example o the laſt Problem will ſerve here, if inſtead o 3.544 you make uſe of 42.53 (which i found by Multiplying 3.544 by 12.)

Example 1.

The Circumference is 36 Inches, and the Length 10 Feet, What is the Content?

Set 42.53 upon D, to 10 upon C, and againſt 36 upon D, is 7.16 upon C, which is the Content (in Feet) ſought.

Example 2.

Let the Circumference be 48 Inches, and the Length 20 Feet, What is the Content?

Set 42.53 upon D, to 20 upon C, and againſt 48 upon D, is 25.46 upon C, and ſo many Feet doth this Tree Contain.

Probl.

Probl. XVII.

The Circumference of any Round Tree being given, to find how much in Length it will take to make a Solid Foot.

First in Feet Measure, the Proportion is,

As the Circumference upon D, is to 1 upon C,

So is 3.544 upon D, to the length sought upon C.

Example.

If the Circumference of a Tree be 3 Feet, How many Feet in length will it take to make a Solid Foot.

Set 3 upon D, to 1 upon C, and against 3.544 upon D, is 1.396 upon C, that is, 1 Foot and .396 parts. Now so many times as this is contained in the Length of the Tree, so many Feet does the Tree contain.

Secondly

Secondly, in Inch Meaſure, if the C
cumference be given in Inches: *Say*,

As the Circumference upon D, is
12 upon C,
So is 42.53 upon D, to the length
Inches (upon C) to make a Foot.

Example.

The Circumference of a Tree is 48 I
ches, How many Inches in Length w
take to make a Foot.

Set 48 upon D, to 12 upon C, and agai
42.53 upon D, is 9.42 upon C, that is,
Inches and .42 parts, the length required.

Note, In all that hath been ſaid of Rou
Timber, we ſuppoſe the Tree to be equal
thick from end to end. But ſeeing mo
Trees are leſs towards the Top than at th
Root, the Circumference muſt be taken i
the middle, and if the ends differ much i
will be the more exact if you divide th
Length into two equal parts, and take th
Circumference in the middle of each, an
ſo find the Content as if they were tw
Trees, Theſe Contents added together give
the Content of the whole.

Fo

For Instance.

There is a Tree 12 Foot Long, the Circumference at one end is 6 Foot, and at the other end 3 Foot, the Sum of theſe is 9, the half is 4.5 the Circumference in the middle, by which (and the Length) the Content will be found (by Prob. 15.) to be 19.36.

But if this Tree be divided into two parts, ſo as each may be 6 Foot long, the Circumference in the middle of the greater will be 5.25, by which the Content will be found to be 13.19.

And the Circumference in the middle of the leſſer piece will be 3.75, and the Content of this will be 6.72, which added to the Content of the other, *viz.* 13.19 gives 20 Foot, the Content of the whole Tree: Whereas the Content found by one Circumference taken in the middle of the whole Tree is but 19.36.

If any deſire to be more exact let them obſerve the Directions given (in page 99 of the Book) for finding the Content of the Fruſtum of a Pyramid, for by thoſe Rules the Content of any Round Taper Tree may be exactly found.

But in most Cases it will be sufficient to take the Circumference in the middle of the Tree, and so find the Content as in Probl. 15, aforegoing.

Observe also, in Taper Trees when it is said so much in length will make a Foot, it must be understood in that place only where the Circumference was taken, for it will not take so much in length of the greater end of a Tree to make a Foot as it will of the lesser.

Yet, if by the Circumference taken in the middle you find the length of a Foot, that length so found will shew the whole Content of the Tree, as in Probl. 17.

Probl. XVIII.

The Circumference of any Round Tree being given either in Feet or in Inches, to find how many Solid Feet are contain'd in one Foot of the Length.

Rule.

If the Circumference be given in Feet, Set 3.544 upon D, to 1 upon C; then against the Circumference upon D, is the Content upon C.

Example.

Example.

Let the Circumference of a Round Tree be 4 Foot, How many Solid Feet are contain'd in one Foot of the length of this Tree? Answer 1.275: For,

As 3.544 upon D, is to 1 upon C,
So is 4 upon D, to 1.275 upon C.

If the Circumference be given in Inches, make use of 42.53, instead of 3.544, and then the Proportion will hold as above.

What hath been done by the Circumference and length, may be also perform'd by the length and Diameter.

Probl. XIX.

The Diameter, Length and Content of any Round Tree, any two of these being given in Foot-measure to find the other.

1. *By the Length and Diameter to find the Content.*

Rule.

(The Diameter of a Circle whose Area is 1 is 1.128: Therefore say,)

As 1.128 upon D, is to the leng[th] upon C,

So is the Diameter upon D, to the Co[n]tent upon C.

Example.

The Diameter is 2 Foot, and the leng[th] 20 Foot, What is the Content?

Set 1.128 upon D, to 20 upon C, a[nd] against 2 upon D, is 62.83 upon C, th[e] Content required.

2. *By the Diameter and Content to find the Length.*

The Proportion is,

As the Diameter upon D, is to th[e] Content upon C.

So is 1.128 upon D, to the length fough[t] upon C;

3. *By the Content and Length to find the Diameter.*

The Proportion is,

As the length upon C, is to 1.128 upon D,

So is the Content upon C, to the Diameter fought upon D.

Probl.

Probl. XX.

The Diameter given in Inches and the Length in Feet, to find the Content in Feet.

This differs not from the last, if instead of 1.128 you make use of 13.53 (which is found by Multiplying 1.128 by 12.)

Example.

The Diameter is 24 Inches, and the Length 20 Feet, What is the Content?

Set 13.53 upon D, to 20 upon C, and against 24 upon D, is 62.83 upon C, the Content as before.

Probl. XXI.

The Diameter of any Round Tree being given, to find how much in length it will take to make a Foot.

1. *In Foot-Measure: The Proportion is,*

As the Diameter upon D, is to 1 upon C, *So* is 1.128 upon D, to the length sought upon C.

Example.

The Diameter is 2 Foot: Therefore,

Set 2 upon D, to 1 upon C, and again 1.128 upon D, is .318 upon C, and many parts of a Foot in length it will ta to make a Foot.

2. *In Inch-Measure: The Proportion is,*

As the Diameter upon D, is to upon C,
So is 13.53 upon D, to the length sough upon C.

Example.

The Diameter is 24 Inches: Therefore

Set 24 upon D, to 12 upon C, an against 13.53 upon D, is 3.81 upon C that is, 3 Inches and .81 parts, the length sought.

Of

Of Square Timber.

Probl. XXII.

The Length, Side, and Content of any piece of Square Timber; any two of these being given in Foot-Measure to find the other.

1. By the Length and Side to find the Content.

The Proportion is,

As 1 upon D, is to the Length upon C:
So is the side upon D, to the Content upon C.

Example 1.

There is a piece of Timber exactly Square, each side at either end being 1.5 Foot, and the Length 20 Foot, How many Solid Feet doth this piece contain?

Set 1 upon D, to 20 upon C, and against 1.5 upon D, is 45 upon C, which is the Content sought.

Example 2.

Let the length be 22.5 Foot, and th[e] side 1 Foot and 2 tenths, What is th[e] Content? Answer 32.4. For,

Set 1 upon D, to 22.5 upon C, an[d] against 1.2 upon D, is 32.4 upon C.

And as the Rule now stands you have th[e] Content of all Square Solids whose lengt[h] is 22.5 Foot, for what ever the side be find it upon D, and against it you have th[e] Content upon C: Thus (the length bein[g] 22.5 Foot) when the side

$$\text{is}\begin{Bmatrix}1.4\\1.7\\2.0\end{Bmatrix}\text{the Content will be}\begin{Bmatrix}44.1\\65.025\\90.0\end{Bmatrix}$$

2. *By the side and Content to find the Length.*

The Proportion is,

As the side upon D, is to the Content upon C:

So is 1 upon D, to the length upon C.

Example.

Example.

The side is 1.2 and the Content 45 Foot, What is the length? Answer 20 Foot: For,

As 1.2 (the side) upon D, is to 45 (the Content) upon C.
So is 1 upon D, to 20 the length upon C.

3. *By the Length and Content to find the side.*

The Proportion is,

As the length upon C, is to 1 upon D:
So is the Content upon C, to the side upon D.

Example.

The length is 22.5, and the Content 32.4 Foot, What is the side? Answer, 1.2: For,

As 22.5 (the length) upon C, is to 1 upon D:
So is 32.4 (the Content) upon C, to 1.2 the side upon D.

Probl. XXIII.

The side of any Square Solid being given in Inches, and the length in Feet, to find the Content in Feet.

The Directions in the last Problem will serve here, if instead of 1 you make use of 12.

Example.

Let the side be 18 Inches, and the length 20 Foot, What is the Content in Feet? Answer 45: For,

As 12 upon D, is to 20 the length upon C:
So is 18 the side upon D, to 45 the Content upon C.

When the ends are not exactly Square, (which doth often happen) take the breadth and thickness at the end in Feet and Parts, then (by the 11th Problem of the third Chap.) find a Geometrical mean betwixt them, for the mean thus found is the side of a Square, with which proceed as in the two last Problems.

Or

Or thus,

Having the breadth, thickness and length in Feet, Multiply the breadth by the thickness, and this Product by the length, the last Product will be the Content.

If the breadth and thickness be given in Inches, and the length in Feet, then by the Lines A and B on the Rule.

The Proportion is,

As 1 upon B, to the breadth upon A:
So is the thickness upon B, to a fourth Number.

Again,

As 144 upon B, to the fourth Number upon A:
So is the length upon B, to the Content sought.

But if any such Solid be greater at one end than at the other, (as most are) the exact way to find the Content, is to find the Area of each base (in Foot-measure) then find a Geometrical mean betwixt the said Area's, then if the Sum of these three be Multiplyed by $\frac{1}{3}$ part of the length, the Product is the Content.

The

The use of the Rule in the mensuration of Brick-work.

Brick-work is commonly measured by the Rod-Square, which is 16.5 Feet in length, and as much in breadth, and by consequence each Square Rod doth contain 272.25 Sq. Foot, for 16.5 Multiplyed by 16.5 is 272.25.

Note also, all Brick-work must be reduced to the Standard-measure of one Brick and an half thick.

Probl. XXIV.

The length and height of any Brick Wall being given in Feet, to find the Content in Square Rods at any thickness.

The Rule.

Multiply the height by the length, and divide the Product by 272.25, the Quotient will be the true Content if the Wall be just 1 ½ Brick thick:

If the thickness be more or less: *Then say;*

As 3 to the Number of half Bricks in the thickness of the Wall:

So is the Quotient above found, to the true Content sought. Or

Or having the length and height in Feet, you may find the Content more readily on the Rule by this Proportion,

As 272.25 upon B, to the height upon A: So is the length upon B, to a fourth Number upon A, which is the true Content if the Wall be 1½ Brick thick: If the thickness be more or less, *Say*,

As 3 upon B, to the ½ Bricks thick upon A:
So is the fourth Number above found upon B, to the Content required.

Example.

There is a Wall 16 Foot high, and 97 Foot long: How many Square Rod doth this Wall contain at 1½ Brick thick? Answer 5 Rod and 7 tenth parts: For,

As 272.25 upon B, to 16 the height upon A:
So is 97 the Length upon B, to 5.7 upon A.

Now if the Wall above mention'd were 2½ Bricks thick, it would Contain 9 Rod and an half: For,

As

As 3 upon B, to 5 (the ½ Bricks in 2 upon A:

So is 5.7 (the Content at 1 ½ Brick thic upon B, to 9.5 the Content fought upon

But if a Wall of 16 Foot high, and Foot long were but 1 Brick thick, the Co tent would be but 3 Rod and 8 tenth part For,

As 3 upon B, to 2 (the ½ Bricks in upon A:

So is 5.7 (the Content at 1 ½ thick) upo B, to 3.8 the Content upon A.

Now that (in all these Cases) you may find the Content at one operation: I shal here lay down certain fixt Numbers for any thickness hereafter exprest,

viz. at	1	Bricks thick	408.37
	1½		272.25
	2		204.19
	2½		163.35
	3		136.12
	3½		116.68
	4		102.10
	4½		90.75
	5		81.75

By

By these Numbers the Content of any Wall, at any thickness here mention'd, may be found either by the Pen or Rule, and the Proportion is,

As the Number proper to the thickness is to the height:
So is the length to the Content.

Example.

There is a Wall $4\frac{1}{2}$ Bricks thick, 7 Foot high, and 85 Foot long: How many Square Rod doth this Wall contain?

The proper Number for $4\frac{1}{2}$ Bricks thick is 90.75.

Therefore,

Set 90.75 upon A, to 7 the height upon B; then against 85 the length upon A, is 6.555 upon B, that is, $6\frac{1}{2}$ Rod and something more.

Note, The Decimal parts of a Rod may be reduced into Feet by this proportion;

As 1.00 upon A, to 272.25 upon B,
So is any Decimal upon A, to the Number of Feet upon B.

And thus you may find the Decimal in the last Example, *viz.* .555 is equal to 151 Foot.

Also,

Also,

$\frac{1}{4}$ or .25	of a	68	
$\frac{1}{2}$ or .50	Rod	136	Feet.
$\frac{3}{4}$ or .75	is	204	

Probl. XXV.

The height of any Wall being given in Feet to find how many Feet in length it will tak to make a Square Rod at any thickness abov mention'd.

The Rule.

Set the height upon A, to the Number proper for the thickness upon B, then against 1 upon A, is the length sought upon B.

Example.

There is a Wall 1 ½ Brick thick, and 8 Foot high: How many Feet in length will it take to make a Square Rod? Answer, 34. For,

The proper Number for 1 ½ thick is 272.25.

Therefore,

Therefore,

As 8 (the height) upon A, to 272.25
n B:
So is 1 upon A, to 34 upon B.

---

*e Use of the Rule in the mensuration of Super-
ficies, as Board, Paving, Cieling, Wainscot-
ng, Flooring, Tyling*, &c.

Note, In all Square or oblong Superficies
e Area or Content may be found by this
e proportion:

As 1 upon A, to the breadth upon B:
So is the length upon A, to the Content
pon B.

This proportion will hold in Triangular
perficies alſo, if you take ½ the Perpen-
cular for the breadth, and the ſide upon
hich it falls for the length: And in all
Caſes the Area thus found is,

	Inches	if the ſides	Inches.
Square	Feet	were given	Feet.
	Yards	in	Yards.

But

But in many Cases the sides are given in one kind of Measure, and the Area required in another:

I shall therefore give a few Examples, and so conclude this Appendix.

I. *For Board.*

If the length and breadth be both given in Inches, and the Content sought in Feet:

Say,

As 144 to the breadth:
So is the length to the Content.

Example.

A Board is 14 Inches broad, and 156 Inches long: How many Square Feet doth it contain? Answer 15,16.

For,

As 144 upon A, to 14 the breadth upon B:
So is 156 the length upon A, to 15.16 the Content upon B.

If the Breadth be given in Inches, and the length in Feet:

Say,

As 12 to the breadth:
So is the length to the Content.

Example.

A Board is 14 Inches broad, and 13 Foot long: What is the Content in Feet? Answer, 15.16.

For,

As 12 upon B, to 14 the breadth upon A:
So is 13 the length upon B, to 15.16 the Content upon A.

II. *Of Paving.*

Paviers Work is measured by the Yard Square, which contains 9 Square Feet: The most natural way, is to measure the sides with a Yard divided into 100 equal parts, and then Multiply the breadth by the length, the Product will be the Content in Square Yards: But if the sides be given in Feet.

Say,

Say,

As 9 to the Breadth:
So is the length to the Content.

Example.

There is a Court Paved with Stone, the breadth is 64 Foot, and the length 95 Foot: What is the Content in Square Yards? Answer, 67.55.

For,

As 9 upon A, to 64 the breadth upon B:
So is 95 the length upon A, to 67.55 the Content upon B.

III. *Of Cieling.*

Cieling, and alſo Wainſcoting are meaſured by the Yard Square, and therefore what is ſaid in the Example above may be underſtood here.

IV. Of

IV. *Of Flooring and Tyling.*

These are both meaſured by the Square which contains 100 Square Foot, the ſide being 10 Foot: Therefore if the length and breadth be given in Feet, Multiply the one by the other, and cut off two Figures in the Product, the Remainder ſhews the Content in Squares, and the Figures cut off are the parts of a Square.

Or by the Rule ſay,

As 100 to the breadth in Feet:
So is the length in Feet to the Content in Squares.

Example.

There is a Floor 66 Foot broad and 75 Foot long: How many Squares doth it contain? Anſwer 49.5.

For,

As 100 upon A, to 66 the breadth upon B:
So is 75 the length upon A, to 49.5 the Content upon B.

The like for Tyling.

Laſtly,

Lastly,

The breadth of any Superficies bei[ng] given in Feet or Yards, to find how ma[ny] in length (of either) it will take to make Foot or Yard Square.

The Proportion is,

As the breadth to 1 :
So is 1 to the length sought.

Example.

A Board is 1.5 Foot broad: How much in length will it take to make a Foot Square? Answer .66 :

For,

As 1.5 the breadth upon A, is to 1 upon B :
So is 1 upon A, to .66 upon B.

But all such Questions as this may be resolved by inspection.

Thus,

Thus,

Draw out the sliding piece C D, and it in backward, so as the Line D upon sliding piece may lye by the Line D the Rule, the beginning of one Line ting the end of the other.

The Lines being thus applied find the eadth of any Board (or such like Super-es) upon one Line, and against it you e the length of a Foot or Yard upon the er Line.

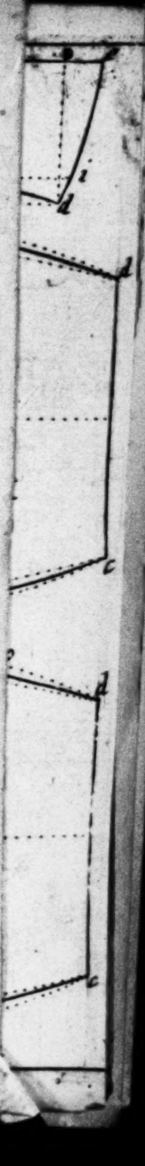
Example.

A Board is two Foot broad: How much length will it take to make a Square ot? Answer .5 tenths or ½ a Foot; for a-inst two Foot the breadth upon one Line, u have .5 upon the other.

Note, when the breadth is above one Foot Yard, the length will be less than one.

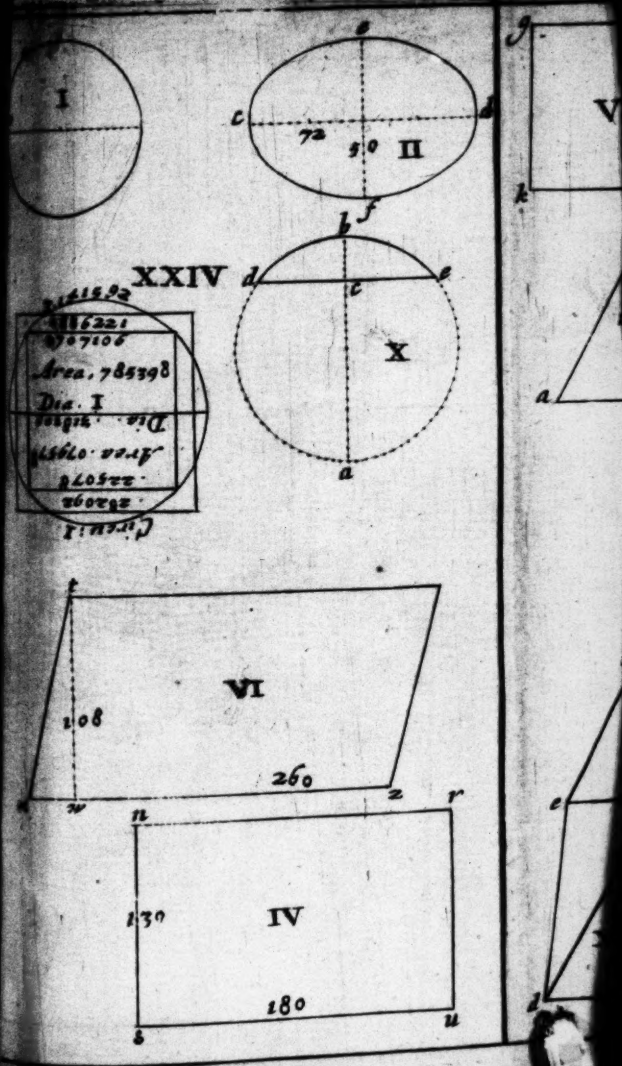
Thus, the breadth of a board being .5 ths of a Foot, it will take two Foot in gth to make a Foot Square, for against upon one Line you have 2 upon the other. like manner if the breadth of a Square perficies be two Yards .5 tenths, the length

to



to make a Yard Square is .4 tenth parts o a Yard: If the breadth were 4 Yards th length will be .25.

By these Lines (as they now stand) man Questions in Solid measure may be also r solved by inspection, but for measuring o Solids the Directions already given ma suffice.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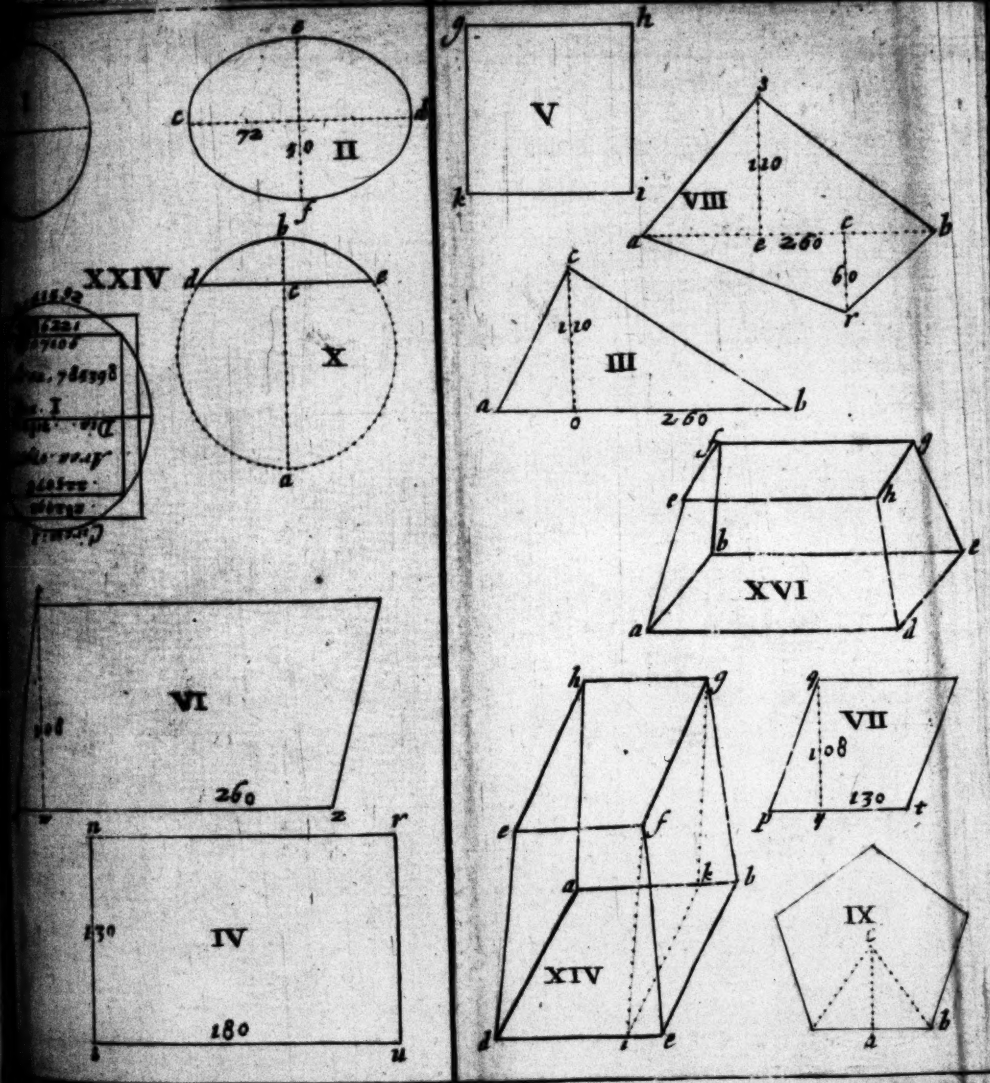
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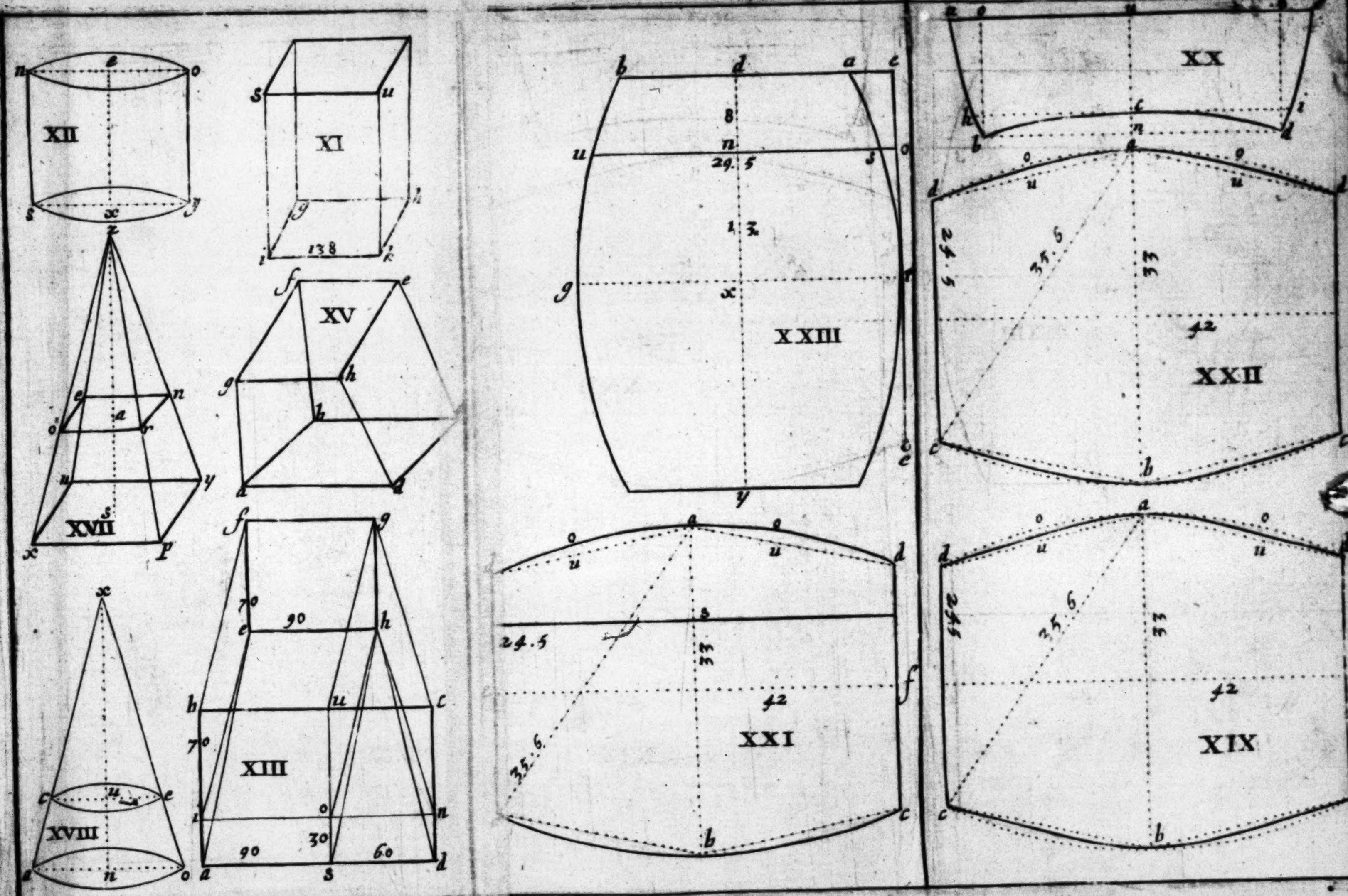
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35. 6

A TABLE OF THE AREA'S of CIRCLES AND Contents *of* Cylinders

In Ale Gallons,

To all Diameters (in Inches and Tenths) from twelve Inches to one hundred fifty and six.

A

Diam. in Inches.	DEPTH. 1	2	3	4
12.0	0.4011	0.80	1.20	1.60
.1	0.4078	0.81	1.22	1.63
.2	0.4146	0.83	1.24	1.65
.3	0.4214	0.84	1.26	1.69
.4	0.4282	0.86	1.28	1.71
.5	0.4352	0.87	1.30	1.74
.6	0.4422	0.88	1.33	1.77
.7	0.4492	0.90	1.35	1.80
.8	0.4563	0.91	1.37	1.82
.9	0.4635	0.93	1.39	1.85
13.0	0.4707	0.94	1.41	1.88
.1	0.4780	0.96	1.43	1.91
.2	0.4853	0.97	1.46	1.94
.3	0.4927	0.98	1.48	1.97
.4	0.5001	1.00	1.50	2.00
.5	0.5076	1.01	1.52	2.03
.6	0.5151	1.03	1.55	2.06
.7	0.5227	1.04	1.57	2.09
.8	0.5304	1.06	1.59	2.12
.9	0.5381	1.08	1.61	2.15
14.0	0.5459	1.09	1.64	2.18
.1	0.5537	1.11	1.66	2.21
.2	0.5616	1.12	1.68	2.24
.3	0.5695	1.14	1.71	2.28
.4	0.5775	1.15	1.73	2.31
.5	0.5856	1.17	1.76	2.34
.6	0.5937	1.19	1.78	2.37
.7	0.6018	1.20	1.80	2.40
.8	0.6100	1.22	1.83	2.44
.9	0.6183	1.24	1.85	2.47

DEPTH.				
5	6	7	8	9
2.01	2.41	2.81	3.21	3.61
2.04	2.44	2.85	3.26	3.67
2.07	2.49	2.90	3.31	3.73
2.11	2.53	2.95	3.37	3.79
2.14	2.57	3.00	3.43	3.86
2.18	2.61	3.05	3.48	3.92
2.21	2.65	3.10	3.54	3.98
2.24	2.69	3.14	3.59	4.04
2.28	2.73	3.19	3.65	4.10
2.32	2.78	3.24	3.71	4.17
2.35	2.82	3.30	3.77	4.24
2.39	2.87	3.35	3.82	4.30
2.43	2.91	3.39	3.88	4.36
2.46	2.95	3.44	3.94	4.43
2.50	3.00	3.50	4.00	4.50
2.53	3.04	3.55	4.06	4.56
2.58	3.09	3.61	4.12	4.63
2.61	3.13	3.65	4.18	4.70
2.65	3.18	3.71	4.24	4.77
2.69	3.23	3.77	4.30	4.84
2.73	3.27	3.82	4.36	4.91
2.75	3.32	3.87	4.42	4.98
2.81	3.37	3.93	4.49	5.05
2.84	3.41	3.98	4.55	5.12
2.88	3.46	4.04	4.62	5.19
2.93	3.51	4.10	4.68	5.26
2.96	3.56	4.15	4.74	5.34
3.01	3.61	4.21	4.81	5.41
3.05	3.66	4.27	4.88	5.49
3.09	3.71	4.33	4.94	5.56

Diam. in Inches.	DEPTH.			
	1	2	3	4
15.0	0.6266	1.25	1.88	2.50
·1	0.6350	1.27	1.91	2.54
·2	0.6435	1.29	1.93	2.57
·3	0.6520	1.30	1.96	2.61
·4	0.6605	1.32	1.98	2.64
·5	0.6691	1.34	2.01	2.68
·6	0.6778	1.35	2.03	2.71
·7	0.6865	1.37	2.06	2.74
·8	0.6953	1.39	2.09	2.78
·9	0.7041	1.41	2.11	2.82
16.0	0.7130	1.43	2.14	2.85
·1	0.7219	1.44	2.16	2.89
·2	0.7309	1.46	2.19	2.92
·3	0.7400	1.48	2.22	2.96
·4	0.7491	1.50	2.25	3.00
·5	0.7582	1.52	2.27	3.03
·6	0.7654	1.53	2.30	3.07
·7	0.7767	1.55	2.33	3.10
·8	0.7861	1.57	2.36	3 14
·9	0.7954	1.59	2.39	3.18
17.0	0.8049	1.61	2.41	3.22
·1	0.8144	1.63	2.44	3.26
·2	0.8239	1.64	2.47	3.29
·3	0.8335	1.67	2.50	3.33
·4	0.8432	1.69	2.53	3.37
·5	0.8529	1.70	2.56	3.41
·6	0.8627	1.72	2.58	3.45
·7	0.8725	1.74	2.62	3.49
·8	0.8824	1.76	2.65	3.53
·9	0.8924	1.78	2.68	3.57

DEPTH.				
5	6	7	8	9
3.13	3.76	4.38	5.01	5.63
3.18	3.81	4.45	5.08	5.72
3.22	3.86	4.50	5.15	5.79
3.26	3.91	4.56	5.22	5.87
3.30	3.95	4.62	5.28	5.94
3.35	4.01	4.68	5.35	6.02
3. 9	4.06	4.74	5.42	6.[illegible]
3.43	4.12	4.80	5.49	6.[illegible]
3.48	4.17	4.87	5.56	6.26
3.52	4.22	4.93	5.63	6.34
3.57	4.28	4.99	5.70	6.42
3.61	4.33	5.05	5.78	6.50
3.65	4.39	5.12	5.85	6.58
3.70	4.44	5.18	5.92	6.66
3.75	4.49	5.24	5.99	6.74
3.79	4.55	5.31	6.06	6.82
3.84	4.60	5.37	6.14	6.90
3.88	4.66	5.43	6.21	6.99
3.93	4.71	5.50	6.28	7.07
3.98	4.77	5.57	6.36	7.16
4.02	4.83	5.63	6.44	7.24
4.07	4.88	5.70	6.51	7.33
4.12	4.94	5.77	6.59	7.42
4.17	5.00	5.83	6.66	7.50
4.22	5.06	5.90	6.74	7.59
4.26	5.11	5.97	6.82	7.68
4.31	5.17	6.03	6.90	7.76
4.36	5.23	6.10	6.98	7.85
4.41	5.29	6.17	7.06	7.94
4.46	5.35	6.24	7.14	8.03

Diam. in Inches.	DEPTH. 1	2	3	4	5
18.0	0.9024	1.80	2.71	3.61	4.51
.1	0.9124	1.82	2.74	3.6[illegible]	4.5[illegible]
.2	0.9225	1.84	2.77	3.69	4.6[illegible]
.3	0.9327	1.87	2.80	3.7[illegible]	4.6[illegible]
.4	0.9429	1.88	2.83	3.77	4.7[illegible]
.5	0.9532	1.91	2.86	3.81	4.7[illegible]
.6	0.9635	1.93	2.89	3.8[illegible]	4.8[illegible]
.7	0.9739	1.95	2.92	3.90	4.8[illegible]
.8	0.9843	1.97	2.95	3.94	4.9[illegible]
.9	0.9948	1.99	2.98	3.98	4.9[illegible]
19.0	1.0054	2.01	3.02	4.02	5.0[illegible]
.1	1.0160	2.03	3.05	4.06	5.0[illegible]
.2	1.0267	2.05	3.08	4.11	5.1[illegible]
.3	1.0374	2.07	3.11	4.15	5.1[illegible]
.4	1.0482	2.10	3.14	4.19	5.2[illegible]
.5	1.0590	2.12	3.18	4.24	5.[illegible]
.6	1.0699	2.14	3.21	4.28	5.[illegible]
.7	1.0808	2.16	3.24	4.32	5.[illegible]
.8	1.0918	2.18	3.27	4.37	5.[illegible]
.9	1.1029	2.21	3.31	4.41	5.[illegible]
20.0	1.1140	2.23	3.34	4.46	5.[illegible]
.1	1.1252	2.25	3.38	4.50	5.[illegible]
.2	1.1364	2.27	3.41	4.55	5.[illegible]
.3	1.1477	2.29	3.44	4.59	5.[illegible]
.4	1.1590	2.32	3.48	4.64	5[illegible]
.5	1.1704	2.34	3.51	4.68	[illegible]
.6	1.1819	2.36	3.54	4.73	[illegible]
.7	1.1934	2.39	3.58	4.77	[illegible]
.8	1.2049	2.41	3.61	4.82	[illegible]
.9	1.2165	2.43	3.65	4.86	[illegible]

DEPTH.				
5	6	7	8	9
4.51	5.41	6.31	7.22	8.12
4.56	5.47	6.38	7.30	8.21
4.61	5.53	6.45	7.38	8.30
4.66	5.59	6.53	7.46	8.39
4.71	5.66	6.60	7.54	8.49
4.77	5.72	6.67	7.63	8.58
4.82	5.78	6.74	7.71	8.67
4.87	5.85	6.82	7.79	8.77
4.92	5.90	6.89	7.87	8.86
4.97	5.97	6.96	7.95	8.95
5.03	6.03	7.04	8.04	9.05
5.08	6.10	7.11	8.13	9.14
5.13	6.16	7.18	8.21	9.23
5.19	6.22	7.26	8.30	9.34
5.24	6.29	7.34	8.38	9.43
5.30	6.35	7.41	8.47	9.53
5.35	6.42	7.49	8.56	9.63
5.40	6.49	7.57	8.65	9.73
5.46	6.55	7.64	8.74	9.83
5.51	6.62	7.72	8.82	9.93
5.57	6.68	7.80	8.91	10.03
5.63	6.75	7.88	9.00	10.13
5.68	6.82	7.95	9.09	10.23
5.74	6.88	8.03	9.18	10.33
5.80	6.95	8.11	9.27	10.43
5.85	7.02	8.19	9.36	10.53
5.91	7.09	8.27	9.46	10.64
5.97	7.16	8.35	9.54	10.74
6.02	7.23	8.43	9.64	10.84
6.08	7.30	8.51	9.73	10.94

Diam. in Inches.	DEPTH. 1	2	3	4
21.0	1.2282	2.46	3.68	4.91
.1	1.2400	2.48	3.72	4.96
.2	1.2517	2.50	3.75	5.01
.3	1.2635	2.53	3.79	5.05
.4	1.2754	2.55	3.83	5.10
.5	1.2874	2.57	3.86	5.15
.6	1.2994	2.60	3.90	5.20
.7	1.3114	2.62	3.39	5.25
.8	1.3236	2.65	3.97	5.29
.9	1.3357	2.67	4.01	5.34
22.0	1.3480	2.70	4.04	5.39
.1	1.3602	2.72	4.08	5.44
.2	1.3726	2.75	4.12	5.49
.3	1.3850	2.77	4.16	5.54
.4	1.3974	2.79	4.19	5.59
.5	1.4099	2.82	4.23	5.64
.6	1.4225	2.84	4.27	5.69
.7	1.4351	2.87	4.31	5.74
.8	1.4478	2.90	4.34	5.79
.9	1.4605	2.92	4.38	5.84
23.0	1.4733	2.95	4.42	5.89
.1	1.4861	2.97	4.46	5.94
.2	1.4990	3.00	4.50	6.01
.3	1.5120	3.02	4.54	6.05
.4	1.5250	3.05	4.58	6.10
.5	1.5380	3.08	4.61	6.15
.6	1.5511	3.10	4.65	6.20
.7	1.5643	3.13	4.69	6.26
.8	1.5775	3.15	4.73	6.31
.9	1.5908	3.18	4.77	6.36

DEPTH.				
5	6	7	8	9
6.14	7.37	8.60	9.82	11.05
6.20	7.44	8.68	9.92	11.16
6.26	7.51	8.76	10.01	11.26
6.32	7.58	8.84	10.11	11.37
6.38	7.65	8.93	10.20	11.48
6.44	7.72	9.01	10.30	11.59
6.50	7.80	9.09	10.39	11.69
6.56	7.87	9.18	10.49	11.80
6.62	7.94	9.26	10.59	11.91
6.68	8.01	9.35	10.68	12.02
6.74	8.09	9.44	10.78	12.13
6.80	8.16	9.52	10.83	12.24
6.86	8.23	9.61	10.98	12.35
6.93	8.31	9.70	11.08	12.47
6.99	8.38	9.78	11.18	12.58
7.05	8.46	9.87	11.28	12.69
7.11	8.53	9.96	11.38	12.80
7.18	8.61	10.05	11.48	12.92
7.24	8.68	10.13	11.58	13.02
7.30	8.76	10.22	11.68	13.14
7.37	8.84	10.31	11.78	13.26
7.43	8.92	10.40	11.89	13.37
7.50	8.99	10.49	11.99	13.49
7.56	9.07	10.58	12.10	13.61
7.63	9.15	10.68	12.20	13.73
7.69	9.23	10.77	12.30	13.84
7.76	9.31	10.86	12.41	13.96
7.82	9.39	10.95	12.51	14.08
7.89	9.46	11.04	12.62	14.20
7.95	9.54	11.13	12.72	14.31

Diam. in Inches.	DEPTH.			
	1	2	3	4
24.0	1.6042	3.21	4.81	6.4
.1	1.6176	3.23	4.85	6.4
.2	1.6310	3.26	4.89	6.5
.3	1.6445	3.29	4.93	6.5
.4	1.6581	3.32	4.97	6.6
.5	1.6717	3.34	5.01	6.6
.6	1.6854	3.37	5.06	6.7
.7	1.6991	3.40	5.10	6.8
.8	1.7129	3.43	5.14	6.8
.9	1.7267	3.45	5.18	6.9
25.0	1.7406	3.48	5.22	6.9
.1	1.7546	3.51	5.26	7.0
.2	1.7686	3.54	5.31	7.0
.3	1.7827	3.57	5.35	7.1
.4	1.7968	3.59	5.39	7.1
.5	1.8110	3.62	5.43	7.2
.6	1.8252	3.65	5.48	7.3
.7	1.8395	3.68	5.52	7.3
.8	1.8538	3.71	5.56	7.4
.9	1.8682	3.74	5.60	7.47
26.0	1.8827	3.77	5.65	7.53
.1	1.8972	3.79	5.69	7.59
.2	1.9117	3.82	5.73	7.6
.3	1.9264	3.85	5.78	7.71
.4	1.9411	3.88	5.82	7.7
.5	1.9558	3.91	5.87	7.82
.6	1.9706	3.94	5.91	7.88
.7	1.9854	3.97	5.96	7.94
.8	2.0003	4.00	6.00	8.00
.9	2.0153	4.03	6.05	8.06

DEPTH.				
5	6	7	8	9
8.02	9.62	11.23	12.83	14.44
8.09	9.70	11.32	12.93	14.55
8.16	9.79	11.42	13.05	14.68
8.22	9.86	11.51	13.15	14.80
8.29	9.95	11.61	13.26	14.92
8.36	10.03	11.70	13.37	15.04
8.43	10.11	11.80	13.48	15.17
8.50	10.19	11.89	13.59	15.29
8.56	10.28	11.99	13.70	15.42
8.63	10.36	12.08	13.81	15.54
8.70	10.44	12.18	13.92	15.67
8.77	10.53	12.28	14.03	15.79
8.84	10.61	12.38	14.15	15.91
8.91	10.70	12.47	14.26	16.04
8.98	10.78	12.57	14.37	16.17
9.06	10.87	12.68	14.49	16.30
9.13	10.95	12.78	14.60	16.43
9.20	11.04	12.88	14.71	16.55
9.27	11.12	12.98	14.83	16.69
9.34	11.21	13.08	14.94	16.81
9.41	11.29	13.18	15.06	16.94
9.49	11.38	13.28	15.18	17.07
9.56	11.47	13.38	15.29	17.20
9.63	11.56	13.48	15.41	17.34
9.70	11.65	13.59	15.53	17.47
9.78	11.73	13.69	15.65	17.60
9.85	11.82	13.79	15.76	17.74
9.93	11.91	13.90	15.88	17.87
10.00	12.00	14.00	16.00	18.00
10.08	12.09	14.11	16.12	18.14

Diam. in Inches.	DEPTH. 1	2	3	4
27.0	2.0303	4.06	6.09	8.1[illegible]
.1	2.0454	4.09	6.14	8.1[illegible]
.2	2.0605	4.12	6.18	8.2[illegible]
.3	2.0757	4.15	6.23	8.3[illegible]
.4	2.0909	4.18	6.27	8.3[illegible]
.5	2.1062	4.21	6.32	8.[illegible]
.6	2.1215	4.24	6.36	8.[illegible]
.7	2.1369	4.27	6.41	8.[illegible]
.8	2.1524	4.30	6.46	8.[illegible]
.9	2.1679	4.33	6.50	8.[illegible]
28.0	2.1835	4.37	6.55	8.[illegible]
.1	2.1991	4.40	6.60	8.[illegible]
.2	2.2148	4.43	6.64	8.[illegible]
.3	2.2305	4.46	6.69	8.[illegible]
.4	2.2463	4.49	6.74	8.[illegible]
.5	2.2621	4.52	6.79	9.[illegible]
.6	2.2780	4.56	6.83	9.[illegible]
.7	2.2940	4.59	6.88	9.[illegible]
.8	2.3100	4.62	6.93	9.[illegible]
.9	2.3261	4.65	6.98	9.[illegible]
29.0	2.3422	4.68	7.03	9.[illegible]
.1	2.3584	4.72	7.07	9.[illegible]
.2	2.3746	4.75	7.12	9.[illegible]
.3	2.3910	4.78	7.17	9.[illegible]
.4	2.4073	4.81	7.22	9.[illegible]
.5	2.4237	4.85	7.27	9.[illegible]
.6	2.4401	4.88	7.32	9.[illegible]
.7	2.4567	4.91	7.37	9.[illegible]
.8	2.4732	4.94	7.42	9.[illegible]
.9	2.4899	4.98	7.47	9.[illegible]

DEPTH.				
5	6	7	8	9
10.15	12.18	14.21	16.24	18.27
10.23	12.27	14.32	16.36	18.41
10.30	12.36	14.42	16.48	18.54
10.38	12.45	14.53	16.61	18.68
10.45	12.55	14.64	16.73	18.82
10.53	12.64	14.74	16.85	18.95
10.61	12.73	14.85	16.97	19.09
10.68	12.82	14.96	17.10	19.23
10.76	12.91	15.06	17.22	19.37
10.84	13.01	15.18	17.34	19.51
10.92	13.10	15.28	17.46	19.65
11.00	13.19	15.39	17.59	19.79
11.08	13.29	15.50	17.71	19.93
11.15	13.38	15.61	17.84	20.07
11.23	13.48	15.72	17.97	20.22
11.31	13.57	15.83	18.10	20.36
11.39	13.67	15.95	18.22	20.50
11.47	13.76	16.06	18.35	20.65
11.55	13.86	16.17	18.48	20.79
11.63	13.96	16.28	18.61	20.93
11.71	14.05	16.39	18.74	21.08
11.79	14.15	16.51	18.86	21.22
11.87	14.25	16.62	18.99	21.37
11.96	14.35	16.74	19.13	21.52
12.04	14.44	16.85	19.26	21.66
12.12	14.54	16.96	19.39	21.81
12.20	14.64	17.08	19.52	21.95
12.28	14.74	17.19	19.65	22.10
12.[illegible]7	14.84	17.31	19.78	22.26
12.45	14.94	17.43	19.02	[illegible]

Diam. in Inches.	DEPTH. 1	2	3	4
30.0	2.5066	5.01	7.52	10.0[illegible]
.1	2.5233	5.05	7.57	10.0[illegible]
.2	2.5401	5.08	7.62	10.1[illegible]
.3	2.5570	5.11	7.67	10.2[illegible]
.4	2.5739	5.15	7.72	10.2[illegible]
.5	2.5908	5.18	7.77	10.3[illegible]
.6	2.6078	5.21	7.82	10.4[illegible]
.7	2.6249	5.25	7.87	10.5[illegible]
.8	2.6420	5.28	7.93	10.5[illegible]
.9	2.6592	5.32	7.98	10.6[illegible]
31.0	2.6764	5.35	8.03	10.7[illegible]
.1	2.6938	5.39	8.08	10.7[illegible]
.2	2.7111	5.42	8.13	10.8[illegible]
.3	2.7285	5.46	8.19	10.9[illegible]
.4	2.7460	5.49	8.24	10.9[illegible]
.5	2.7635	5.53	8.29	11.0[illegible]
.6	2.7811	5.56	8.34	11.1[illegible]
.7	2.7987	5.60	8.40	11.1[illegible]
.8	2.8163	5.63	8.45	11.2[illegible]
.9	2.8341	5.67	8.50	11.3[illegible]
32.0	2.8519	5.70	8.56	11.41
.1	2.8698	5.74	8.61	11.48
.2	2.8877	5.78	8.66	11.55
.3	2.9057	5.81	8.72	11.62
.4	2.9237	5.85	8.77	11.69
.5	2.9418	5.88	8.83	11.77
.6	2.9599	5.92	8.88	11.84
.7	2.9781	5.96	8.93	11.91
.8	2.9963	5.99	8.99	11.98
.9	3.0146	6.03	9.04	12.06

DEPTH.				
5	6	7	8	9
12.53	15.04	17.54	20.05	22.56
12.62	15.14	17.66	20.18	22.71
12.70	15.24	17.78	20.32	22.86
12.79	15.34	17.90	20.46	23.01
12.87	15.44	18.02	20.59	23.17
12.95	15.55	18.14	20.73	23.32
13.04	15.65	18.25	20.86	23.47
13.12	15.75	18.37	21.00	23.62
13.21	15.85	18.49	21.14	23.78
13.30	15.95	18.61	21.27	23.93
13.38	16.06	18.73	21.41	24.09
13.47	16.16	18.86	21.55	24.25
13.56	16.27	18.98	21.69	24.40
13.64	16.37	19.10	21.83	24.56
13.73	16.48	19.22	21.97	24.71
13.82	16.58	19.34	22.10	24.87
13.91	16.69	19.47	22.25	25.03
13.99	16.79	19.59	22.38	25.18
14.08	16.90	19.71	22.53	25.35
14.17	17.00	19.84	22.67	25.51
14.25	17.11	19.96	22.82	25.67
14.35	17.22	20.09	22.96	25.83
14.44	17.32	20.21	23.10	25.98
14.53	17.43	20.34	23.24	26.15
14.62	17.54	20.46	23.39	26.31
14.71	17.65	20.59	23.53	26.48
14.80	17.76	20.72	23.68	26.64
14.89	17.87	20.85	23.82	26.80
14.98	17.98	20.97	23.97	26.97
15.07	18.09	21.10	24.11	27.1[illegible]

Diam. in Inches.	DEPTH.			
	1	2	3	4
33.0	3.0330	6.07	9.10	12.
.1	3.0514	6.10	9.15	12.2
.2	3.0698	6.14	9.21	12.2
.3	3.0884	6.18	9.26	12.
.4	3.1069	6.21	9.32	12.
.5	3.1256	6.25	9.38	12.
.6	3.1443	6.29	9.43	12.
.7	3.1630	6.33	9.49	12.
.8	3.1818	6.36	9.55	12.7
.9	3.2007	6.40	9.60	12.
34.0	3.2196	6.44	9.66	12.8
.1	3.2385	6.48	9.71	12.9
.2	3.2576	6.51	9.77	13.0
.3	3.2766	6.55	9.83	13.1
.4	3.2958	6.59	9.89	13.1
.5	3.3150	6.63	9.95	13.2
.6	3.3342	6.67	10.00	13.
.7	3.3535	6.71	10.06	13.4
.8	3.3728	6.75	10.12	13.4
.9	3.3923	6.78	10.18	13.5
35.0	3.4117	6.82	10.24	13.6
.1	3.4312	6.86	10.29	13.7
.2	3.4508	6.90	10.35	13.8
.3	3.4705	6.94	10.41	13.8
.4	3.4902	6.98	10.47	13.9
.5	3.5099	7.02	10.53	14.0
.6	3.5297	7.06	10.59	14.1
.7	3.5496	7.10	10.65	14.2
.8	3.5695	7.14	10.71	14.2
.9	3.5894	7.18	10.77	14.3

DEPTH.				
5	6	7	8	9
15.17	18.20	21.23	24.26	27.30
15.26	18.31	21.36	24.41	27.46
15.35	18.42	21.49	24.56	27.63
15.44	18.53	21.62	24.71	27.79
15.53	18.64	21.75	24.85	27.96
15.63	18.75	21.88	25.00	28.13
15.72	18.86	22.01	25.15	28.30
15.82	18.98	22.14	25.30	28.47
15.91	19.09	22.27	25.45	28.63
16.00	19.20	22.40	25.60	28.80
16.10	19.32	22.54	25.75	28.97
16.19	19.43	22.67	25.90	29.14
16.29	19.54	22.80	26.06	29.32
16.38	19.66	22.93	26.21	29.49
16.48	19.77	23.07	26.36	29.66
16.58	19.89	23.21	26.52	29.84
16.67	20.00	23.34	26.67	30.01
16.77	20.12	23.47	26.82	30.18
16.86	20.23	23.61	26.98	30.35
16.96	20.35	23.75	27.14	30.53
17.06	20.47	23.88	27.29	30.70
17.16	20.59	24.01	27.45	30.88
17.25	20.70	24.16	27.61	31.06
17.35	20.82	24.29	27.76	31.24
17.45	20.94	24.43	27.92	31.41
17.55	21.06	24.57	28.08	31.59
17.65	21.18	24.71	28.24	31.76
17.75	21.30	24.85	28.39	31.94
17.85	21.42	24.99	28.55	32.13
17.95	21.53	25.12	28.71	32.30

Diam. in Inches.	DEPTH.			
	1	2	3	4
36.0	3.6095	7.22	10.83	14.4
.1	3.6295	7.26	10.89	14.5
.2	3.6497	7.30	10.95	14.6
.3	3.6699	7.34	11.01	14.6
.4	3.6901	7.38	11.07	14.7
.5	3.7104	7.42	11.13	14.8
.6	3.7308	7.46	11.19	14.9
.7	3.7512	7.50	11.25	15.0
.8	3.7717	7.54	11.32	15.0
.9	3.7922	7.58	11.38	15.1
37.0	3.8128	7.63	11.44	15.2
.1	3.8334	7.67	11.50	15.3
.2	3.8541	7.71	11.56	15.4
.3	3.8749	7.75	11.62	15.5
.4	3.8957	7.79	11.69	15.5
.5	3.9165	7.83	11.75	15.6
.6	3.9374	7.87	11.81	15.7
.7	3.9584	7.92	11.88	15.83
.8	3.9794	7.96	11.94	15.92
.9	4.0005	8.00	12.00	16.00
38.0	4.0217	8.04	12.06	16.09
.1	4.0428	8.09	12.13	16.17
.2	4.0641	8.13	12.17	16.24
.3	4.0854	8.17	12.26	16.34
.4	4.1068	8.21	12.32	16.43
.5	4.1282	8.26	12.38	16.51
.6	4.1496	8.30	12.45	16.60
.7	4.1712	8.34	12.51	16.68
.8	4.1927	8.39	12.58	16.77
.9	4.2144	8.43	12.64	16.86

DEPTH.				
5	6	7	8	9
18.05	21.66	25.27	28.87	32.48
18.15	21.78	25.41	29.03	32.66
18.25	21.90	25.55	29.19	32.84
18.35	22.02	25.69	29.36	33.03
18.45	22.14	25.83	29.52	33.21
18.55	22.26	25.97	29.68	33.39
18.65	22.39	26.11	29.85	33.58
18.76	22.51	26.26	30.01	33.76
18.86	22.63	26.40	30.17	33.94
18.96	22.75	26.55	30.34	34.13
19.07	22.88	26.69	30.51	34.32
19.17	23.00	26.83	30.67	34.50
19.27	23.12	26.98	30.83	34.69
19.37	23.25	27.12	31.00	34.87
19.48	23.37	27.27	31.17	35.06
19.58	23.50	27.41	31.33	35.25
19.69	23.62	27.56	31.50	35.43
19.79	23.75	27.71	31.66	35.62
19.90	23.87	27.86	31.83	35.81
20.00	24.00	28.00	32.00	36.00
20.11	24.13	28.15	32.17	36.19
20.21	24.26	28.30	32.34	36.39
20.30	24.36	28.43	32.49	36.56
20.43	24.51	28.60	32.68	36.77
20.54	24.64	28.75	32.85	36.96
20.64	24.77	28.90	33.02	37.15
20.75	24.90	29.05	33.19	37.34
20.86	25.03	29.20	33.37	37.54
20.95	25.15	29.35	33.54	37.73
21.07	25.29	29.50	33.71	37.93

Diam. in Inches.	DEPTH. 1	2	3	4
39.0	4.2361	8.47	12.71	16.9
.1	4.2578	8.52	12.77	17.0
.2	4.2796	8.56	12.84	17.1
.3	4.3015	8.60	12.90	17.2
.4	4.3234	8.65	12.97	17.2
.5	4.3454	8.69	13.04	17.3
.6	4.3674	8.73	13.10	17.4
.7	4.3895	8.78	13.17	17.5
.8	4.4117	8.82	13.24	17.6
.9	4.4338	8.87	13.30	17.7
40.0	4.4562	8.91	13.37	17.8
.1	4.4785	8.96	13.43	17.9
.2	4.5008	9.00	13.50	18.0
.3	4.5233	9.05	13.57	18.09
.4	4.5457	9.09	13.64	18.18
.5	4.5683	9.14	13.71	18.27
.6	4.5908	9.18	13.77	18.36
.7	4.6135	9.23	13.84	18.45
.8	4.6362	9.27	13.91	18.54
.9	4.6589	9.32	13.98	18.64
41.0	4.6818	9.36	14.05	18.73
.1	4.7046	9.41	14.11	18.82
.2	4.7275	9.45	14.18	18.91
.3	4.7505	9.50	14.25	19.00
.4	4.7735	9.55	14.32	19.09
.5	4.7966	9.59	14.39	19.19
.6	4.8198	9.64	14.46	19.28
.7	4.8430	9.69	14.53	19.37
.8	4.8662	9.73	14.60	19.46
.9	4.8895	9.78	14.67	19.56

DEPTH.				
5	6	7	8	9
21.18	25.42	29.65	33.89	38.12
21.29	25.55	29.81	34.06	38.32
21.40	25.68	29.95	34.23	38.51
21.51	25.81	30.11	34.41	38.71
21.62	25.94	30.26	34.58	38.91
21.73	26.07	30.42	34.76	39.11
21.84	26.20	30.57	34.94	39.30
21.95	26.33	30.72	35.11	39.50
22.06	26.47	30.89	35.30	39.71
22.17	26.60	31.04	35.47	39.91
22.28	26.74	31.19	35.65	40.11
22.39	26.87	31.35	35.83	40.30
22.50	27.00	31.51	36.01	40.51
22.62	27.14	31.66	36.18	40.71
22.73	27.28	31.82	36.37	40.91
22.84	27.41	31.98	36.54	41.11
22.95	27.55	32.14	36.73	41.32
23.07	27.68	32.29	36.91	41.52
23.18	27.82	32.45	37.09	41.72
23.30	27.95	32.61	37.27	41.93
23.41	28.09	32.77	37.46	42.14
23.52	28.22	32.93	37.63	42.34
23.64	28.36	33.09	37.82	42.54
23.75	28.50	33.25	38.00	42.75
23.87	28.64	33.41	38.19	42.96
23.98	28.78	33.57	38.37	43.17
24.10	28.92	33.74	38.56	43.38
24.22	29.06	33.90	38.74	43.59
24.33	29.19	34.06	38.93	43.80
24.45	29.34	34.23	39.11	44.00

Diam. in Inches.	DEPTH. 1	2	3	4
42.0	4.9129	9.83	14.74	19.65
.1	4.9363	9.87	14.81	19.74
.2	4.9598	9.92	14.88	19.84
.3	4.9834	9.97	14.95	19.93
.4	5.0069	10.01	15.02	20.03
.5	5.0306	10.06	15.09	20.12
.6	5.0543	10.11	15.16	20.22
.7	5.0780	10.16	15.23	20.31
.8	5.1019	10.20	15.31	20.41
.9	5.1257	10.25	15.38	20.50
43.0	5.1496	10.30	15.45	20.60
.1	5.1736	10.35	15.52	20.69
.2	5.1977	10.40	15.59	20.79
.3	5.2218	10.44	15.67	20.89
.4	5.2459	10.49	15.74	20.93
.5	5.2701	10.54	15.81	21.08
.6	5.2944	10.59	15.88	21.18
.7	5.3187	10.64	15.96	21.28
.8	5.3430	10.69	16.03	21.37
.9	5.3675	10.74	16.10	21.47
44.0	5.3920	10.78	16.18	21.57
.1	5.4165	10.83	16.25	21.67
.2	5.4411	10.88	16.32	21.76
.3	5.4657	10.93	16.40	21.86
.4	5.4904	10.98	16.47	21.96
.5	5.5152	11.03	16.55	22.06
.6	5.5400	11.08	16.62	22.16
.7	5.5649	11.13	16.70	22.26
.8	5.5898	11.18	16.77	22.36
.9	5.6148	11.23	16.85	22.46

DEPTH.				
5	6	7	8	9
24.57	29.48	34.39	39.30	44.22
24.68	29.62	34.55	39.49	44.43
24.80	29.76	34.72	39.68	44.64
24.92	29.90	34.88	39.86	44.85
25.04	30.04	35.05	40.06	45.06
25.16	30.19	35.22	40.25	45.28
25.27	30.33	35.38	40.43	45.49
25.39	30.47	35.55	40.62	45.70
25.51	30.61	35.72	40.82	45.92
25.63	30.76	35.88	41.01	46.14
25.75	30.90	36.05	41.19	46.34
25.87	31.04	36.21	41.39	46.56
25.99	31.19	36.39	41.59	56.78
26.11	31.33	36.56	41.78	47.00
26.23	31.48	36.72	41.97	47.22
26.35	31.62	36.89	42.16	47.43
26.47	31.77	37.06	42.35	47.65
26.59	31.91	37.23	42.55	47.87
26.72	32.06	37.40	42.75	48.09
26.84	32.20	37.57	42.94	48.31
26.96	32.35	37.74	43.14	48.53
27.08	32.50	37.91	43.33	48.75
27.21	32.65	37.09	43.53	48.97
27.33	32.80	38.26	43.73	49.19
27.45	32.94	38.43	43.92	49.41
27.58	33.09	38.61	44.12	49.64
27.70	33.24	38.78	44.32	49.86
27.83	33.39	38.96	44.52	50.09
27.95	33.54	39.13	44.72	50.31
28.08	33.69	39.31	44.92	50.54

Diam. in Inches.	DEPTH.			
	1	2	3	4
42.0	4.9129	9.83	14.74	19.65
.1	4.9363	9.87	14.81	19.74
.2	4.9598	9.92	14.88	19.84
.3	4.9834	9.97	14.95	19.93
.4	5.0069	10.01	15.02	20.03
.5	5.0306	10.06	15.09	20.12
.6	5.0543	10.11	15.16	20.22
.7	5.0780	10.16	15.23	20.31
.8	5.1019	10.20	15.31	20.41
.9	5.1257	10.25	15.38	20.50
43.0	5.1496	10.30	15.45	20.60
.1	5.1736	10.35	15.52	20.69
.2	5.1977	10.40	15.59	20.79
.3	5.2218	10.44	15.67	20.89
.4	5.2459	10.49	15.74	20.99
.5	5.2701	10.54	15.81	21.08
.6	5.2944	19.59	15.88	21.18
.7	5.3187	10.64	15.96	21.28
.8	5.3430	10.69	16.03	21.37
.9	5.3675	19.74	16.10	21.47
44.0	5.3920	10.78	16.18	21.57
.1	5.4165	10.83	16.25	21.67
.2	5.4411	10.88	16.32	21.76
.3	5.4657	10.93	16.40	21.86
.4	5.4904	10.98	16.47	21.96
.5	5.5152	11.03	16.55	22.06
.6	5.5400	11.08	16.62	22.16
.7	5.5649	11.13	16.70	22.26
.8	5.5898	11.18	16.77	22.36
.9	5.6148	11.23	16.85	22.46

DEPTH.				
5	6	7	8	9
24.57	29.48	34.39	39.30	44.22
24.68	29.62	34.55	39.49	44.43
24.80	29.76	34.72	39.68	44.64
24.92	29.90	34.88	39.86	44.85
25.04	30.04	35.05	40.06	45.06
25.16	30.19	35.22	40.25	45.28
25.27	30.33	35.38	40.43	45.49
25.39	30.47	35.55	40.62	45.70
25.51	30.61	35.72	40.82	45.92
25.63	30.76	35.88	41.01	46.14
25.75	30.90	36.05	41.19	46.34
25.87	31.04	36.21	41.39	46.56
25.99	31.19	36.39	41.59	56.78
26.11	31.33	36.56	41.78	47.00
26.23	31.48	36.72	41.97	47.22
26.35	31.62	36.89	42.16	47.43
26.47	31.77	37.06	42.35	47.65
26.59	31.91	37.23	42.55	47.87
26.72	32.06	37.40	42.75	48.09
26.84	32.20	37.57	42.94	48.31
26.96	32.35	37.74	43.14	48.53
27.08	32.50	37.91	43.33	48.75
27.21	32.65	37.09	43.53	48.97
27.33	32.80	38.26	43.73	49.19
27.45	32.94	38.43	43.92	49.41
27.58	33.09	38.61	44.12	49.64
27.70	33.24	38.78	44.32	49.86
27.83	33.39	38.96	44.52	50.09
27.95	33.54	39.13	44.72	50.31
28.08	33.69	39.31	44.92	50.54

Diam. in Inches.	DEPTH. 1	2	3	4
45.0	5.6398	11.28	16.92	22.5
.1	5.6649	11.33	17.00	22.6
.2	5.6901	11.38	17.07	22.7
.3	5.7153	11.43	17.15	22.8
.4	5.7405	11.48	17.22	22.9
.5	5.7659	11.53	17.30	23.0
.6	5.7912	11.58	17.37	23.1
.7	5.8167	11.63	17.45	23.2
.8	5.8421	11.68	17.53	23.3
.9	5.8677	11.74	17.60	23.4
46.0	5.8933	11.79	17.68	23.5
.1	5.9189	11.84	17.76	23.6
.2	5.9446	11.89	17.84	23.7
.3	5.9704	11.94	17.91	23.8
.4	5.9962	11.99	17.99	23.9
.5	6.0221	12.04	18.07	24.
.6	6.0480	12.10	18.14	24.1
.7	6.0740	12.15	18.22	24.3
.8	6.1000	12.20	18.30	24.4
.9	6.1261	12.25	18.38	24.5
47.0	6.1523	12.30	18.46	24.6
.1	6.1735	12.36	18.54	24.7
.2	6.2048	12.41	18.61	24.8
.3	6.2311	12.46	18.69	24.9
.4	6.2575	12.52	18.78	25.0
.5	6.2839	12.57	18.85	25.1
.6	6.3104	12.62	18.93	25.2
.7	6.3369	12.67	19.01	25.3
.8	6.3635	12.73	19.09	25.4
.9	6.3902	12.78	19.17	25.5

DEPTH.				
5	6	7	8	9
28.20	33.84	39.48	45.12	50.76
28.33	33.99	39.66	45.32	50.99
28.45	34.14	39.83	45.52	51.21
28.58	34.29	40.01	45.72	51.44
28.70	34.44	40.18	45.92	51.66
28.83	34.50	40.36	46.13	51.90
28.96	34.75	40.54	46.33	52.12
29.09	34.90	40.72	46.54	52.35
29.21	35.05	40.90	46.74	52.58
29.34	35.21	41.08	46.94	52.81
29.47	35.36	41.25	47.15	53.04
29.60	35.51	41.43	47.35	53.27
29.73	35.67	41.62	47.56	53.51
29.85	35.82	41.79	47.76	53.73
29.98	35.98	41.97	47.97	53.97
30.11	36.13	42.15	48.18	54.20
30.24	36.29	42.34	48.38	54.43
30.37	36.44	42.52	48.59	54.67
30.50	36.60	42.70	48.80	54.90
30.63	36.76	42.88	49.01	55.13
30.76	36.91	43.07	49.22	55.37
30.89	37.07	43.25	49.43	55.60
31.03	37.23	43.44	49.64	55.85
31.16	37.39	43.62	49.85	56.08
31.29	37.55	43.81	50.07	56.32
31.42	37.71	43.99	50.27	56.56
31.55	37.86	44.17	50.48	56.79
31.69	38.02	44.36	50.70	57.03
31.82	38.18	44.54	50.91	57.27
31.95	38.34	44.73	51.12	57.51

Diam. in Inches.	DEPTH. 1	2	3	4
48.0	6.4169	12.83	19.25	25.67
.1	6.4436	12.89	19.33	25.78
.2	6.4705	12.94	19.41	25.88
.3	6.4973	12.99	19.49	25.99
.4	6.5243	13.05	19.57	26.10
.5	6.5513	13.10	19.65	26.20
.6	6.5783	13.16	19.74	26.31
.7	6.6054	13.21	19.82	26.42
.8	6.6325	13.27	19.90	26.53
.9	6.6600	13.32	19.98	26.64
49.0	6.6870	13.37	20.06	26.74
.1	6.7143	13.43	20.14	26.86
.2	6.7417	13.48	20.23	26.97
.3	6.7692	13.54	20.31	27.08
.4	6.7966	13.59	20.39	27.19
.5	6.8242	13.65	20.47	27.30
.6	6.8518	13.70	20.56	27.41
.7	6.8794	13.76	20.64	27.52
.8	6.9072	13.81	20.72	27.63
.9	6.9349	13.87	20.81	27.74
50.0	6.9628	13.93	20.89	27.85
.1	6.9906	13.98	20.97	27.96
.2	7.0186	14.04	21.06	28.08
.3	7.0466	14.09	21.14	28.19
.4	7.0746	14.15	21.22	28.30
.5	7.1027	14.21	21.31	28.41
.6	7.1309	14.26	21.39	28.52
.7	7.1591	14.32	21.48	28.64
.8	7.1873	14.38	21.56	28.75
.9	7.2157	14.43	21.65	28.86

DEPTH.				
5	6	7	8	9
32.08	38.50	44.92	51.34	57.75
32.22	38.56	45.11	51.55	58.00
32.35	38.82	45.29	51.76	58.23
32.49	38.98	45.48	51.98	58.48
32.62	39.15	45.67	52.19	58.72
32.76	39.31	45.86	52.41	58.96
32.89	39.47	46.05	52.63	59.20
33.03	39.63	46.24	52.84	59.45
33.16	39.79	46.43	53.06	59.69
33.30	39.96	46.62	53.28	59.94
33.43	40.12	46.80	53.49	60.18
33.57	40.29	47.00	53.71	60.43
33.71	40.45	47.20	53.94	60.68
33.85	40.61	47.38	54.15	60.92
33.99	40.78	47.58	54.38	61.17
34.12	40.95	47.77	54.59	61.42
34.26	41.11	47.97	54.82	61.67
34.40	41.28	48.15	55.03	61.91
34.54	41.44	48.35	55.26	62.16
34.68	41.61	48.55	55.48	62.42
34.82	41.78	48.74	55.71	62.66
34.96	41.95	48.94	55.93	62.92
35.10	42.11	49.13	56.15	63.17
35.24	42.28	49.33	56.38	63.42
35.38	42.45	49.53	56.60	63.68
35.52	42.62	49.72	56.83	63.93
35.66	42.79	49.92	57.05	64.18
35.80	42.96	50.11	57.27	64.43
35.94	43.12	50.31	57.50	64.69
36.08	43.30	50.51	57.73	64.94

Diam. in Inches.	DEPTH. 1	2	3	4
51.0	7.2440	14.49	21.73	28.98
.1	7.2725	14.55	21.82	29.09
.2	7.3010	14.60	21.90	29.20
.3	7.3295	14.66	21.99	29.32
.4	7.3581	14.72	22.07	29.43
.5	7.3869	14.77	22.16	29.55
.6	7.4155	14.83	22.25	29.66
.7	7.4443	14.89	22.33	29.78
.8	7.4731	14.95	22.42	29.89
.9	7.5020	15.00	22.51	30.01
52.0	7.5309	15.06	22.59	30.12
.1	7.5599	15.12	22.68	30.24
.2	7.5890	15.18	22.77	30.36
.3	7.6181	15.24	22.86	30.47
.4	7.6472	15.29	22.94	30.59
.5	7.6764	15.35	23.03	30.71
.6	7.7057	15.41	23.12	30.83
.7	7.7350	15.47	23.21	30.94
.8	7.7644	15.53	23.29	31.06
.9	7.7939	15.59	23.38	31.18
53.0	7.8233	15.65	23.47	31.29
.1	7.8529	15.71	23.56	31.41
.2	7.8825	15.76	23.65	31.53
.3	7.9122	15.82	23.74	31.65
.4	7.9419	15.88	23.83	31.77
.5	7.9717	15.94	23.92	31.89
.6	8.0015	16.00	24.00	32.01
.7	8.0314	16.06	24.09	32.13
.8	8.0613	16.12	24.18	32.24
.9	8.0913	16.18	24.27	32.36

DEPTH.				
5	6	7	8	9
36.22	43.47	50.71	57.95	65.20
36.36	43.63	50.91	58.18	65.45
36.51	43.81	51.11	58.41	65.71
36.65	43.97	51.30	58.63	65.96
36.79	44.15	51.51	58.87	66.22
36.94	44.32	51.71	59.10	66.48
37.08	44.49	51.91	59.32	66.74
37.22	44.66	52.11	59.55	67.00
37.37	44.84	52.31	59.79	67.26
37.51	45.01	52.52	60.02	67.52
37.66	45.19	52.72	60.25	67.78
37.80	45.36	52.92	60.48	68.04
37.95	45.53	53.12	60.71	68.30
38.09	45.71	53.33	60.95	68.56
38.24	45.88	53.53	61.18	68.82
38.38	46.06	53.73	61.41	69.09
38.53	46.24	53.94	61.65	69.36
38.68	46.41	54.15	61.88	69.62
38.82	46.59	54.35	62.11	69.88
38.97	46.76	54.56	62.35	70.15
39.12	46.94	54.76	62.59	70.41
39.27	47.12	54.97	62.82	70.68
39.41	47.29	55.18	63.06	70.94
39.56	47.47	55.39	63.30	71.21
39.71	47.65	55.60	63.54	71.48
39.86	47.83	55.81	63.78	71.75
40.01	48.01	56.01	64.01	72.01
40.16	48.19	56.22	64.25	72.28
40.31	48.37	56.43	64.49	72.55
40.46	48.55	56.64	64.73	72.82

Diam. Inches.	DEPTH. 1	2	3	4
54.0	8.1214	16.24	24.36	32.49
.1	8.1515	16.30	24.45	32.61
.2	8.1816	16.36	24.54	32.72
.3	8.2118	16.42	24.64	32.85
.4	8.2421	16.48	24.73	32.97
.5	8.2724	16.54	24.82	33.09
.6	8.3028	16.61	24.91	33.22
.7	8.3333	16.67	25.00	33.33
.8	8.3638	16.72	25.09	33.46
.9	8.3943	16.79	25.18	33.58
55.0	8.4249	16.85	25.27	33.70
.1	8.4556	16.91	25.37	33.82
.2	8.4863	16.97	25.46	33.95
.3	8.5171	17.03	25.55	34.07
.4	8.5479	17.10	25.64	34.19
.5	8.5788	17.16	25.74	34.32
.6	8.6097	17.22	25.83	34.44
.7	8.6407	17.28	25.92	34.56
.8	8.6718	17.34	26.01	34.68
.9	8.7029	17.40	26.11	34.81
56.0	8.7341	17.47	26.20	34.94
.1	8.7653	17.53	26.30	35.06
.2	8.7966	17.59	26.39	35.19
.3	8.8279	17.66	26.48	35.31
.4	8.8593	17.72	26.58	35.44
.5	8.8907	17.78	26.67	35.56
.6	8.9222	17.84	26.77	35.69
.7	8.9538	17.91	26.86	35.82
.8	8.9854	17.97	26.96	35.94
.9	9.0171	18.03	27.05	36.07

DEPTH.				
5	6	7	8	9
40.61	48.73	56.85	64.97	73.09
40.76	48.91	57.06	65.21	73.36
40.91	49.09	57.27	65.45	73.63
41.06	49.27	57.49	65.70	73.91
41.21	49.45	57.70	65.94	74.18
41.36	49.63	57.91	66.18	74.45
41.52	49.82	58.12	66.43	74.73
41.67	50.00	58.33	66.67	75.00
41.82	50.19	58.55	66.91	75.28
41.97	50.37	58.76	67.15	75.55
42.12	50.55	58.98	67.40	75.83
42.28	50.74	59.19	67.65	76.11
42.43	50.92	59.40	67.89	76.38
42.59	51.10	59.62	68.14	76.66
42.74	51.29	59.84	68.39	76.93
42.90	51.48	60.05	68.63	77.21
43.05	51.66	60.27	68.88	77.49
43.20	51.85	60.49	69.13	77.77
43.36	52.03	60.70	69.37	78.04
43.52	52.22	60.92	69.62	78.33
43.67	52.40	61.14	69.87	78.61
43.83	52.59	61.36	70.12	78.89
43.99	52.78	61.58	70.38	79.18
44.14	52.97	61.80	70.62	79.45
44.30	53.16	62.01	70.87	79.73
44.46	53.35	62.24	71.13	80.02
44.61	53.53	62.46	71.38	80.30
44.77	53.72	62.68	71.63	80.59
44.93	53.91	62.90	71.88	80.87
45.09	54.10	63.12	72.14	81.15

Diam. in Inches.	DEPTH. 1	2	3	4
57.0	9.0489	18.10	27.15	36.2
.1	9.0806	18.16	27.24	36.3
.2	9.1124	18.22	27.34	36.4
.3	9.1443	18.29	27.43	36.5
.4	9.1762	18.35	27.53	36.7
.5	9.2082	18.42	27.62	36.8
.6	9.2403	18.48	27.72	36.9
.7	9.2724	18.54	27.82	37.0
.8	9.3046	18.61	27.91	37 2
.9	9.3368	18.67	28.01	37.3
58.0	9.3691	18.74	28.11	37.4
.1	9.4014	18.80	28.20	37.6
.2	9.4338	18.87	28.30	37.7
.3	9.4662	18.93	28.40	37.8
.4	9.4988	19.00	28.50	38.0
.5	9.5313	19.06	28.59	38.1
.6	9.5639	19.13	28.69	38.2
.7	9.5966	19.19	28.79	38.3
.8	9.6293	19.26	28.89	38.5
.9	9.6621	19.32	28.99	38.6
59.0	9.6949	19.39	29.08	38.7
.1	9.7278	19.46	29.19	38.9
.2	9.7608	19.52	29.28	39.0
.3	9.7938	19.59	29.38	39.1
.4	9.8268	19.65	29.48	39.3
.5	9.8600	19.72	29.58	39.4
.6	9.8931	19.79	29.68	39.5
.7	9.9263	19.85	29.78	39.7
.8	9.9596	19.92	29.88	39.8
.9	9.9930	19.99	29.98	39.9

DEPTH.				
5	6	7	8	9
45.25	54.29	63.34	72.39	81.44
45.40	54.48	63.56	72.65	81.73
45.56	54.67	63.79	72.90	82.01
45.72	54.87	64.01	73.15	82.30
45.88	55.06	64.23	73.41	82.59
46.04	55.25	64.46	73.67	82.87
46.20	55.44	64.68	73.92	83.16
46.36	55.63	64.91	74.18	83.45
46.52	55.83	65.13	74.43	83.74
46.69	56.02	65.36	74.70	84.03
46.85	56.21	65.58	74.95	84.32
47.01	56.41	65.81	75.21	84.61
47.17	56.60	66.04	75.47	84.91
47.33	56.80	66.26	75.73	85.20
47.50	56.99	66.49	75.99	85.49
47.66	57.19	66.72	76.25	85.78
47.82	57.38	66.95	76.51	86.08
47.98	57.58	67.17	76.77	86.37
48.15	57.77	67.40	77.03	86.66
48.31	57.97	67.63	77.30	86.96
48.48	58.17	67.87	77.56	87.26
48.64	58.46	68.10	77.82	87.55
48.81	58.57	68.33	78.09	87.85
48.97	58.77	68.56	78.35	88.15
49.14	58.96	68.79	78.62	88.44
49.30	59.16	69.02	78.88	88.74
49.47	59.36	69.25	79.15	89.04
49.63	59.56	69.48	79.41	89.34
49.80	59.75	69.71	79.67	89.63
49.97	59.96	69.95	79.95	89.94

Diam. in Inches.	DEPTH. 1	2	3	4
60.0	10.0264	20.05	30.08	40.1[illegible]
.1	10.0598	20.12	30.18	40.2[illegible]
.2	10.0933	20.19	30.28	40.37
.3	10.1269	20.25	30.38	40.5[illegible]
.4	10.1605	20.32	30.48	40.6[illegible]
.5	10.1942	20.39	30.58	40.7[illegible]
.6	10.2279	20.46	30.68	40.9[illegible]
.7	10.2617	20.52	30.78	41.04
.8	10.2955	20.59	30.89	41.18
.9	10.3294	20.66	30.99	41.32
61.0	10.3634	20.73	31.09	41.45
.1	10.3974	20.80	31.19	41.59
.2	10.4314	20.86	31.29	41.72
.3	10.4655	20.93	31.40	41.86
.4	10.4997	21.00	31.50	42.00
.5	10.5339	21.07	31.60	42.14
.6	10.5682	21.14	31.70	42.27
.7	10.6026	21.21	31.81	42.41
.8	10.6370	21.27	31.91	42.55
.9	10.6714	21.34	32.01	42.68
62.0	10.7059	21.41	32.11	42.82
.1	10.7405	21.48	32.22	42.96
.2	10.7751	21.55	32.33	43.10
.3	10.8098	21.62	32.43	43.24
.4	10.8445	21.69	32.53	43.38
.5	10.8793	21.76	32.64	43.52
.6	10.9141	21.83	32.74	43.66
.7	10.9490	21.90	32.85	43.80
.8	10.9840	21.97	32.95	43.94
.9	10.0190	22.04	33.06	44.08

DEPTH.				
5	6	7	8	9
50.13	60.16	70.18	80.21	90.23
50.30	60.36	70.42	80.48	90.54
50.47	60.56	70.65	80.75	90.84
50.64	60.76	70.89	81.02	91.14
50.80	60.96	71.12	81.28	91.45
50.97	61.17	71.36	81.55	91.75
51.14	61.37	71.60	81.82	92.05
51.31	61.57	71.83	82.09	92.35
51.48	61.77	72.07	82.36	92.66
51.65	61.97	72.30	82.63	92.96
51.81	62.18	72.54	82.90	93.27
51.99	62.38	72.78	83.18	93.58
52.16	62.59	73.02	83.45	93.88
52.33	62.79	73.26	83.72	94.19
52.50	63.00	73.50	84.00	94.50
52.67	63.20	73.74	84.27	94.81
52.84	63.41	73.98	84.55	95.11
53.02	63.62	74.22	84.82	95.43
53.19	63.82	74.46	85.10	95.73
53.36	63.04	74.70	85.37	96.04
53.53	64.24	74.94	85.65	96.35
53.70	64.44	75.18	85.92	96.66
53.88	64.65	75.43	86.20	96.98
54.05	64.86	75.67	86.48	97.29
54.22	65.06	75.91	86.75	97.60
54.40	65.27	76.15	87.03	97.91
54.57	65.48	76.40	87.31	98.23
54.75	65.69	76.64	87.59	98.54
54.92	65.91	76.89	87.87	98.86
55.10	66.11	77.13	88.15	99.17

Diam in Inches.	DEPTH. 1	2	3	4
63.0	11.0541	22.11	33.16	44.
.1	11.0892	22.18	33.27	44.
.2	11.1244	22.25	33.37	44.
.3	11.1596	22.32	33.48	44.
.4	11.1949	22.39	33.59	44.
.5	11.2302	22.46	33.69	44.
.6	11.2656	22.53	33.79	45.
.7	11.3011	22.60	33.90	45.
.8	11.3366	22.67	34.01	45.
.9	11.3721	22.74	34.12	45.
64.0	11.4078	22.82	34.22	45.
.1	11.4434	22.89	34.33	45.
.2	11.4792	22.96	34.44	45.
.3	11.5150	23.03	34.54	46.
.4	11.5508	23.10	34.65	46.
.5	11.5867	23.17	34.76	46.
.6	11.6227	23.25	34.87	46.
.7	11.6587	23.32	34.98	46.
.8	11.6947	23.39	35.08	46.
.9	11.7309	23.46	35.19	46.
65.0	11.7670	23.53	35.30	47.
.1	11.8033	23.60	35.40	47.
.2	11.8396	23.68	35.52	47.
.3	11.8759	23.75	35.62	47.
.4	11.9123	23.82	35.74	47.
.5	11.9488	23.90	35.85	47.
.6	11.9853	23.97	35.96	47.
.7	12.0219	24.04	36.07	48.
.8	12.0585	24.12	36.17	48.
.9	12.0952	24.19	36.28	48.

	DEPTH.				
4	5	6	7	8	9
44.	55.27	66.32	77.38	88.43	99.49
44.	55.45	66.53	77.62	88.71	99.80
44.	55.62	66.75	77.87	88.99	100.12
44.	55.80	66.96	78.12	89.28	100.44
44.	55.98	67.17	78.37	89.56	100.76
44.	56.15	67.38	78.61	89.84	101.07
45.	56.33	67.60	78.86	90.13	101.40
45.	56.51	67.81	79.11	90.41	101.71
45.	56.69	68.02	79.36	90.70	102.03
45.	56.86	68.23	79.60	90.98	102.35
5.	57.04	68.45	79.86	91.26	102.67
5.	57.22	68.66	80.10	91.54	102.99
5.	57.40	68.87	80.35	91.83	103.31
6.	57.57	69.09	80.61	92.12	103.64
6.	57.75	69.31	80.86	92.41	103.96
6.	57.94	69.52	81.11	92.70	104.28
6.	58.12	69.74	81.36	92.98	104.61
6.	58.30	69.95	81.61	93.27	104.93
6.	58.47	70.17	81.87	93.56	105.26
6.	58.65	70.39	82.12	93.85	105.58
[illegible]	58.84	70.60	82.37	94.14	105.90
[illegible]	59.01	70.81	82.62	94.42	106.22
[illegible]	59.20	71.04	82.88	94.72	106.56
[illegible]	59.38	71.26	83.13	95.01	106.88
[illegible]	59.56	71.47	83.38	95.30	107.21
[illegible]	59.75	71.69	83.64	95.60	107.54
[illegible]	59.93	71.91	83.90	95.88	107.87
[illegible]	60.11	72.13	84.15	96.18	108.20
[illegible]	60.29	72.35	84.41	96.46	108.52
[illegible]	60.48	72.57	84.67	96.76	108.86

Diam i Inches.	DEPTH. 1	2	3	4
66.0	12.1319	24.26	36.40	48.53
.1	12.1687	24.34	36.51	48.68
.2	12.2055	24.41	36.62	48.82
.3	12.2424	24.48	36.73	48.97
.4	12.2794	24.56	36.84	49.12
.5	12.3164	24.63	36.95	49.27
.6	12.3535	24.71	37.06	49.41
.7	12.3906	24.78	37.17	49.56
.8	12.4278	24.86	37.28	49.71
.9	12.4650	24.93	37.40	49.86
67.0	12.5023	25.00	37.51	50.01
.1	12.5397	25.08	37.62	50.16
.2	12.5771	25.15	37.73	50.31
.3	12.6145	25.23	37.84	50.46
.4	12.6520	25.30	37.96	50.61
.5	12.6896	25.38	38.07	50.76
.6	12.7272	25.45	38.18	50.91
.7	12.7649	25.53	38.30	51.06
.8	12.8027	25.61	38.41	51.21
.9	12.8405	25.68	38.52	51.36
68.0	12.8783	25.76	38.63	51.51
.1	12.9162	25.83	38.75	51.66
.2	12.9542	25.91	38.86	51.82
.3	12.9922	25.98	38.98	51.97
.4	13.0303	26.06	39.09	52.12
.5	13.0684	26.14	39.20	52.27
.6	13.1066	26.21	39.32	52.42
.7	13.1448	26.29	39.44	52.58
.8	13.1831	26.37	39.55	52.73
.0	13.2215	26.44	39.66	52.88

DEPTH.				
5	6	7	8	9
60.66	72.79	84.92	97.06	109.19
60.85	73.01	85.18	97.35	109.52
61.03	73.23	85.44	97.64	109.85
61.21	73.45	85.69	97.94	110.18
61.40	73.67	85.95	98.23	110.51
61.58	73.90	86.21	98.53	110.84
61.77	74.12	86.47	98.83	111.18
61.95	74.34	86.73	99.12	111.51
62.14	74.57	87.00	99.42	111.85
62.33	74.79	87.26	99.72	112.19
62.51	75.01	87.51	100.02	112.52
62.70	75.24	87.78	100.32	112.86
62.89	75.46	88.04	100.62	113.19
63.07	75.68	88.30	100.91	113.53
63.26	75.91	88.56	101.22	113.87
63.45	76.13	88.82	101.56	114.20
63.64	76.36	89.09	101.82	114.54
63.83	76.59	89.36	102.12	114.89
64.02	76.82	89.62	102.42	115.23
64.20	77.04	89.88	102.72	115.56
64.39	77.27	90.14	103.02	115.90
64.58	77.50	90.41	103.33	116.24
64.77	77.72	90.68	103.63	116.59
64.96	77.95	90.94	103.94	116.93
65.15	78.18	91.21	104.24	117.27
65.34	78.41	91.48	104.54	117.61
65.53	78.64	91.74	104.85	117.95
65.73	78.87	92.02	105.16	118.31
65.92	79.10	92.28	105.47	118.65
66.11	79.33	92.55	105.77	118.99

Diam. in Inches.	DEPTH. 1	2	3	4
69.0	13.2599	26.52	39.78	53.0
.1	13.2983	26.60	39.89	53.1
.2	13.3368	26.67	40.01	53.3
.3	13.3754	26.75	40.13	53.5
.4	13.4140	26.83	40.24	53.6
.5	13.4527	26.91	40.36	53.8
.6	13.4915	26.98	40.47	53.9
.7	13.5303	27.06	40.59	54.1
.8	13.5691	27.14	40.71	54.2
.9	13.6080	27.22	40.82	54.4
70.0	13.6470	27.29	40.94	54.5
.1	13.6860	27.37	41.06	54.7
.2	13.7251	27.45	41.18	54.9
.3	13.7642	27.53	41.29	55.0
.4	13.8034	27.61	41.41	55.2
.5	13.8426	27.68	41.53	55.3
.6	13.8819	27.76	41.65	55.5
.7	13.9213	27.84	41.76	55.6
.8	13.9607	27.92	41.88	55.8
.9	14.0002	28.00	42.00	56.00
71.0	14.0397	28.08	42.12	56.16
.1	14.0793	28.16	42.24	56.32
.2	14.1189	28.24	42.36	56.48
.3	14.1586	28.32	42.47	56.63
.4	14.1983	28.40	42.59	56.79
.5	14.2381	28.48	42.71	56.95
.6	14.2780	28.56	42.83	57.11
.7	14.3179	28.64	42.95	57.27
.8	14.3579	28.72	43.07	57.43
.9	14.3979	28.80	43.19	57.59

DEPTH.				
5	6	7	8	9
66.30	79.56	92.82	106.08	119.34
66.49	79.79	93.09	106.38	119.68
66.69	80.02	93.36	106.70	120.03
66.88	80.25	93.63	107.00	120.38
67.07	80.48	93.90	107.31	120.73
67.27	80.72	94.17	107.62	121.08
67.46	80.95	94.44	107.93	121.42
67.65	81.18	94.71	108.24	121.77
67.85	81.41	94.98	108.55	122.12
68.04	81.65	95.26	108.86	122.47
68.24	81.88	95.53	109.18	122.82
68.43	82.12	95.80	109.49	123.17
68.63	82.35	96.08	109.80	123.53
68.82	82.58	96.35	110.11	123.88
69.02	82.82	96.62	110.42	124.23
69.21	83.05	96.87	110.74	124.58
69.41	83.29	97.17	111.06	124.94
69.61	83.53	97.45	111.37	125.29
69.81	83.77	97.73	111.69	125.65
70.00	84.00	98.00	112.00	126.00
70.20	84.24	98.28	112.32	126.36
70.40	84.47	98.55	112.63	126.71
70.60	84.71	98.83	112.95	127.07
70.79	84.95	99.11	113.26	127.42
70.99	85.19	99.39	113.58	127.78
71.19	85.43	99.67	113.90	128.14
71.39	85.67	99.95	114.22	128.50
71.59	85.91	100.23	114.54	128.86
71.79	86.15	100.51	114.86	129.22
71.9[illegible]	86.[illegible]	100.[illegible]	11[illegible].18	129.58

Diam. in Inches.	DEPTH. 1	2	3	4
72.0	14.4380	28.88	43.31	57.75
.1	14.4781	28.96	43.43	57.91
.2	14.5183	29.04	43.55	58.07
.3	14.5585	29.12	43.67	58.23
.4	14.5988	29.20	43.80	58.40
.5	14.6392	29.28	43.92	58.56
.6	14.6796	29.36	44.04	58.72
.7	14.7201	29.44	44.16	58.88
.8	14.7606	29.52	44.28	59.04
.9	14.8012	29.60	44.40	59.20
73.0	14.8418	29.68	44.53	59.37
.1	14.8825	29.76	44.65	59.53
.2	14.9232	29.85	44.77	59.69
.3	14.9640	29.93	44.89	59.86
.4	15.0049	30.01	45.02	60.02
.5	15.0458	30.09	45.14	60.18
.6	15.0868	30.17	45.26	60.35
.7	15.1278	30.26	45.38	60.51
.8	15.1689	30.34	45.51	60.68
.9	15.2100	30.42	45.63	60.84
74.0	15.2512	30.50	45.75	61.00
.1	15.2925	30.58	45.88	61.17
.2	15.3338	30.67	46.00	61.34
.3	15.3751	30.75	46.13	61.50
.4	15.4165	30.83	46.25	61.66
.5	15.4580	30.92	46.37	61.83
.6	15.4950	30.99	46.49	61.98
.7	15.5411	31.08	46.62	62.16
.8	15.5827	31.17	46.75	62.33
.9	15.6244	31.25	46.87	62.50

DEPTH.				
5	6	7	8	9
72.19	86.63	101.07	115.50	129.94
72.39	86.87	101.35	115.82	130.30
72.59	87.11	101.63	116.14	130.66
72.79	87.35	101.91	116.46	131.02
73.00	87.59	102.19	116.79	131.39
73.20	87.83	102.47	117.11	131.75
73.40	88.07	102.75	117.43	132.11
73.60	88.32	103.04	117.76	132.48
73.80	88.56	103.32	118.08	132.84
74.01	88.81	103.61	118.41	133.21
74.21	89.05	103.89	118.74	133.58
74.41	89.29	104.17	119.06	133.94
74.62	89.54	104.46	119.38	134.31
74.82	89.78	104.75	119.71	134.68
75.03	90.03	105.04	120.04	135.05
75.23	90.28	105.32	120.37	135.41
75.44	90.52	105.61	120.70	135.78
75.64	90.77	105.90	121.02	136.15
75.85	91.01	106.18	121.35	136.52
76.05	91.26	106.47	121.68	136.89
76.26	91.51	106.76	122.01	137.26
76.46	91.75	107.04	122.34	137.63
76.67	92.00	107.34	122.67	138.01
76.88	92.25	107.63	123.00	138.38
77.08	92.50	107.91	123.33	138.74
77.29	92.75	108.21	123.66	139.12
77.48	92.97	108.47	123.96	139.46
77.71	93.25	108.79	124.33	139.87
77.92	93.50	109.08	124.66	140.25
78.12	93.74	109.37	124.99	140.62

Diam. in Inches.	DEPTH. 1	2	3	4
72.9	14.4380	28.88	43.31	57.75
.1	14.4781	28.96	43.43	57.91
.2	14.5183	29.04	43.55	58.07
.3	14.5585	29.12	43.67	58.23
.4	14.5988	29.20	43.80	58.40
.5	14.6392	29.28	43.92	58.56
.6	14.6796	29.36	44.04	58.72
.7	14.7201	29.44	44.16	58.88
.8	14.7606	29.52	44.28	59.04
.9	14.8012	29.60	44.40	59.20
73.0	14.8418	29.68	44.53	59.37
.1	14.8825	29.76	44.65	59.53
.2	14.9232	29.85	44.77	59.69
.3	14.9640	29.93	44.89	59.86
.4	15.0049	30.01	45.02	60.02
.5	15.0458	30.09	45.14	60.18
.6	15.0868	30.17	45.26	60.35
.7	15.1278	30.26	45.38	60.51
.8	15.1689	30.34	45.51	60.68
.9	15.2100	30.42	45.63	60.84
74.0	15.2512	30.50	45.75	61.00
.1	15.2925	30.58	45.88	61.17
.2	15.3338	30.67	46.00	61.34
.3	15.3751	30.75	46.13	61.50
.4	15.4165	30.83	46.25	61.66
.5	15.4580	30.92	46.37	61.83
.6	15.4950	30.99	46.49	61.98
.7	15.5411	31.08	46.62	62.16
.8	15.5827	31.17	46.75	62.33
.9	15.6244	31.25	46.87	62.50

DEPTH.				
5	6	7	8	9
72.19	86.63	101.07	115.50	129.94
72.39	86.87	101.35	115.82	130.30
72.59	87.11	101.63	116.14	130.66
72.79	87.35	101.91	116.46	131.02
73.00	87.59	102.19	116.79	131.39
73.20	87.83	102.47	117.11	131.75
73.40	88.07	102.75	117.43	132.11
73.60	88.32	103.04	117.76	132.48
73.80	88.56	103.32	118.08	132.84
74.01	88.81	103.61	118.41	133.21
74.21	89.05	103.89	118.74	133.58
74.41	89.29	104.17	119.06	133.94
74.62	89.54	104.46	119.38	134.31
74.82	89.78	104.75	119.71	134.68
75.03	90.03	105.04	120.04	135.05
75.23	90.28	105.32	120.37	135.41
75.44	90.52	105.61	120.70	135.78
75.64	90.77	105.90	121.02	136.15
75.85	91.01	106.18	121.35	136.52
76.05	91.26	106.47	121.68	136.89
76.26	91.51	106.76	122.01	137.26
76.46	91.75	107.04	122.34	137.63
76.67	92.00	107.34	122.67	138.01
76.88	92.25	107.63	123.00	138.38
77.08	92.50	107.91	123.33	138.74
77.29	92.75	108.21	123.66	139.12
77.48	92.97	108.47	123.96	139.46
77.71	93.25	108.79	124.33	139.87
77.92	93.50	109.08	124.66	140.25
78.12	93.74	109.37	124.99	140.62

Diam. in Inches.	DEPTH. 1	2	3	4
75.0	15.6662	31.33	47.00	62.66
.1	15.7080	31.42	47.12	62.83
.2	15.7499	31.50	47.25	63.00
.3	15.7918	31.58	47.38	63.17
.4	15.8337	31.67	47.50	63.34
.5	15.8758	31.75	47.63	63.50
.6	15.9178	31.84	47.75	63.67
.7	15.9600	31.92	47.88	63.84
.8	16.0022	32.00	48.01	64.01
.9	16.0444	32.09	48.13	64.18
76.0	16.0867	32.17	48.26	64.35
.1	16.1291	32.26	48.39	64.52
.2	16.1715	32.34	48.51	64.68
.3	16.2140	32.43	48.64	64.86
.4	16.2565	32.51	48.77	65.02
.5	16.2991	32.60	48.90	65.20
.6	16.3417	32.68	49.03	65.37
.7	16.3844	32.77	49.15	65.54
.8	16.4272	32.85	49.28	65.71
.9	16.4700	32.94	49.41	65.88
77.0	16.5129	33.03	49.54	66.05
.1	16.5558	33.11	49.67	66.22
.2	16.5988	33.20	49.80	66.40
.3	16.6418	33.28	49.93	66.57
.4	16.6849	33.37	50.06	66.74
.5	16.7280	33.46	50.18	66.91
.6	16.7712	33.54	50.31	67.08
.7	16.8145	33.63	50.44	67.26
.8	16.8578	33.72	50.57	67.43
.0	16 9011	33.80	50.70	67.60

DEPTH.				
5	6	7	8	9
78.33	94.00	109.66	125.33	140.99
78.54	94.25	109.96	125.66	141.37
78.75	94.50	110.25	126.00	141.75
78.96	94.75	110.54	126.34	142.13
79.17	95.00	110.84	126.67	142.51
79.38	95.26	111.13	127.01	142.88
79.59	95.51	111.43	127.34	143.26
79.80	95.76	111.72	127.68	143.64
80.01	96.01	112.01	128.02	144.02
80.22	96.26	112.31	128.35	144.40
80.44	96.52	112.61	128.70	144.78
80.65	96.77	112.90	129.03	145.16
80.86	97.03	113.20	129.37	145.54
81.07	97.28	113.50	129.71	145.93
81.28	97.54	113.79	130.05	146.30
81.50	97.80	114.10	130.40	146.70
81.71	98.05	114.39	130.74	147.08
81.92	98.30	114.69	131.07	147.46
82.14	98.56	114.99	131.42	147.84
82.35	98.82	115.29	131.76	148.23
82.57	99.08	115.59	132.10	148.62
82.78	99.34	115.89	132.45	149.00
83.00	99.59	116.19	132.79	149.39
83.21	99.85	116.49	133.14	149.78
83.43	100.11	116.80	133.48	150.17
83.64	100.37	117.10	133.82	150.55
83.86	100.63	117.40	134.17	150.94
84.07	100.88	117.70	134.51	151.33
84.29	101.15	118.01	134.86	151.72
84.51	101.41	118.31	135.21	152.11

Diam in Inches.	DEPTH. 1	2	3	4
78.0	16.9445	33.89	50.83	67.7
.1	16.9880	33.98	50.96	67.9
.2	17.0315	34.06	51.09	68.1
.3	17.0751	34.15	51.23	68.3
.4	17.1188	34.24	51.36	68.4
.5	17.1625	34.32	51.49	68.6
.6	17.2062	34.41	51.62	68.8
.7	17.2500	34.50	51.75	69.0
.8	17.2939	34.59	51.88	69.1
.9	17.3378	34.68	52.01	69.3
79.0	17.3818	34.76	52.15	69.5
.1	17.4258	34.85	52.28	69.7
.2	17.4699	34.94	52.41	69.8
.3	17.5141	35.03	52.54	70.0
.4	17.5583	35.12	52.67	70.2
.5	17.6025	35.20	52.81	70.4
.6	17.6468	35.29	52.94	70.5
.7	17.6912	35.38	53.07	70.7
.8	17.7356	35.47	53.21	70.9
.9	17.7801	35.56	53.34	71.12
80.0	17.8246	35.65	53.47	71.3
.1	17.8692	35.74	53.61	71.4
.2	17.9139	35.83	53.74	71.66
.3	17.9586	35.92	53.87	71.8
.4	18.0033	36.01	54.01	72.01
.5	18.0481	36.10	54.14	72.19
.6	18.0930	36.19	54.28	72.37
.7	18.1379	36.28	54.41	72.55
.8	18.1829	36.37	54.55	72.73
.9	18.2280	36.46	54.68	72.91

DEPTH.				
5	6	7	8	9
4.72	101.66	118.61	135.55	152.50
4.94	101.93	118.92	135.90	152.89
5.16	102.19	119.22	136.25	153.28
5.38	102.45	119.53	136.60	153.68
5.60	102.71	119.83	136.95	154.07
5.81	102.97	120.13	137.30	154.46
6.03	103.24	120.44	137.65	154.85
6.25	103.50	120.75	138.00	155.25
6.47	103.76	121.06	138.35	155.65
6.69	104.03	121.37	138.70	156.04
6.91	104.29	121.67	139.06	156.44
7.13	104.56	121.98	139.41	156.83
7.35	104.82	122.29	139.76	157.23
7.57	105.08	122.60	140.11	157.63
7.79	105.35	122.91	140.46	158.02
.01	105.61	123.21	140.82	158.42
.24	105.88	123.53	141.18	158.82
.46	106.15	123.84	141.53	159.22
.68	106.41	124.15	141.88	159.62
.90	106.68	124.46	142.24	160.02
9.12	106.94	124.77	142.59	160.42
9.35	107.21	125.08	142.95	160.82
9.57	107.48	125.40	143.31	161.23
9.79	107.75	125.71	143.66	161.62
0.02	108.02	126.02	144.03	162.03
0.24	108.29	126.34	144.39	162.43
0.47	108.56	126.65	144.74	162.84
0.69	108.83	126.97	145.10	163.24
0.92	109.10	127.28	145.46	163.65
1.14	109.37	127.60	145.82	164.05

Diam. in Inches.	DEPTH. 1	2	3	4
81.0	18.2730	36.55	54.82	73.
.1	18.3182	36.64	54.95	73.
.2	18.3634	36.73	55.09	73.
.3	18.4086	36.82	55.22	73.
.4	18.4540	36.91	55.36	73.
.5	18.4993	37.00	55.50	74.
.6	18.5448	37.09	55.64	74.
.7	18.5902	37.18	55.77	74.
.8	18.6358	37.27	55.91	74.
.9	18.6814	37.36	56.04	74.
82.0	18.7270	37.45	56.18	74.
.1	18.7727	37.55	56.32	75.
.2	18.8185	37.64	56.45	75.
.3	18.8643	37.73	56.59	75.
.4	18.9102	37.82	56.73	75.
.5	18.9561	37.91	56.87	75.
.6	19.0021	38.00	57.01	76.
.7	19.0481	38.10	57.14	76.
.8	19.0942	38.19	57.28	76.
.9	19.1403	38.28	57.42	76.
83.0	19.1866	38.37	57.56	76.
.1	19.2328	38.47	57.70	76.
.2	19.2791	38.56	57.84	77.
.3	19.3255	38.65	57.98	77.
.4	19.3719	38.74	58.12	77.
.5	19.4184	38.84	58.25	77.
.6	19.4650	38.93	58.40	77.
.7	19.5115	39.02	58.53	78.
.8	19.5582	39.12	58.67	78.
.9	19.6049	39.21	58.82	78.

DEPTH.				
5	6	7	8	9
91.37	109.64	127.91	146.18	164.46
91.59	109.91	128.23	146.55	164.86
91.82	110.18	128.54	146.91	165.27
92.24	110.45	128.86	147.27	165.67
92.27	110.72	129.18	147.63	166.09
92.50	110.99	129.49	147.99	166.49
92.73	111.27	129.82	148.36	166.91
92.95	111.54	130.13	148.72	167.31
93.18	111.82	130.45	149.09	167.72
93.41	112.09	130.77	149.45	168.13
93.64	112.36	131.09	149.81	168.54
93.87	112.64	131.41	150.18	168.96
94.09	112.91	131.73	150.54	169.36
94.32	113.18	132.05	150.91	169.78
94.55	113.46	132.37	151.28	170.19
94.78	113.74	132.69	151.65	170.60
95.01	114.01	133.01	152.02	171.02
95.24	114.29	133.34	152.39	171.43
95.47	114.56	133.66	152.75	171.85
95.70	114.84	133.98	153.12	172.26
95.93	115.12	134.30	153.49	172.67
96.17	115.40	134.63	153.86	173.10
96.40	115.67	134.95	154.23	173.51
96.63	115.95	135.28	154.60	173.93
96.86	116.23	135.60	154.98	174.35
97.09	116.51	135.93	155.34	174.76
97.33	116.79	136.26	155.72	175.19
97.56	117.07	136.58	156.09	175.60
97.79	117.35	136.91	156.46	176.02
98.02	117.63	137.24	156.84	176.45

A Table of the Area's of Circles

Diam. in Inches.	DEPTH. 1	2	3	4
84.0	19.6517	39.30	58.96	78.61
.1	19.6985	39.40	59.09	78.79
.2	19.7454	39.49	59.24	78.98
.3	19.7923	39.58	59.38	79.17
.4	19.8393	39.68	59.52	79.36
.5	19.8863	39.77	59.66	79.54
.6	19.9334	39.87	59.80	79.73
.7	19.9806	39.96	59.94	79.92
.8	20.0278	40.06	60.08	80.11
.9	20.0750	40.15	60.23	80.30
85.0	20.1223	40.24	60.37	80.49
.1	20.1697	40.34	60.51	80.68
.2	20.2172	40.43	60.65	80.87
.3	20.2646	40.53	60.79	81.06
.4	20.3122	40.62	60.94	81.25
.5	20.3598	40.72	61.08	81.44
.6	20.4074	40.81	61.22	81.63
.7	20.4551	40.91	61.37	81.82
.8	20.5029	41.01	61.51	82.01
.9	20.5507	41.10	61.65	82.20
86.0	20.5986	41.20	61.79	82.39
.1	20.6465	41.29	61.94	82.58
.2	20.6945	41.39	62.08	82.78
.3	20.7426	41.48	62.23	82.97
.4	20.7907	41.58	62.37	83.16
.5	20.8388	41.68	62.52	83.36
.6	20.8870	41.77	62.66	83.55
.7	20.9353	41.87	62.81	83.74
.8	20.9836	41.97	62.95	83.93
.9	21.0320	42.06	63.10	84.13

DEPTH				
5	6	7	8	9
98.26	117.91	137.56	157.22	176.87
98.49	118.19	137.89	157.58	177.28
98.73	118.47	138.22	157.96	177.71
98.96	118.75	138.54	158.34	178.13
99.20	119.03	138.87	158.71	178.55
99.43	119.32	139.20	159.09	178.97
99.67	119.60	139.53	159.46	179.40
99.90	119.88	139.86	159.84	179.82
100.14	120.17	140.20	160.22	180.25
100.38	120.45	140.53	160.60	180.68
100.61	120.73	140.85	160.98	181.10
100.86	121.02	141.19	161.36	181.53
101.09	121.30	141.52	161.74	181.95
101.32	121.58	141.85	162.11	182.38
101.56	121.87	142.18	162.50	182.81
101.80	122.16	142.52	162.88	183.24
102.04	122.44	142.85	163.26	183.66
102.28	122.73	143.19	163.64	184.10
102.52	123.02	143.52	164.02	184.53
102.76	123.31	143.86	164.41	184.96
102.99	123.59	144.19	164.78	185.38
103.23	123.88	144.52	165.17	185.82
103.47	124.16	144.86	165.55	186.25
103.71	124.45	145.19	165.94	186.68
103.96	124.75	145.54	166.33	187.12
104.20	125.03	145.87	166.71	187.55
104.44	125.32	146.21	167.10	187.98
104.68	125.61	146.55	167.48	188.42
104.92	125.90	146.88	167.86	188.85
105.16	126.19	147.22	168.26	189.29

Diam. in Inches.	DEPTH.			
	1	2	3	4
87.0	21.0804	42.16	63.24	84.32
.1	21.1289	42.26	63.39	84.52
.2	21.1775	42.35	63.53	84.71
.3	21.2261	42.45	63.68	84.90
.4	21.2747	42.55	63.83	85.10
.5	21.3234	42.65	63.97	85.29
.6	21.3722	42.74	64.12	85.49
.7	21.4210	42.84	64.26	85.68
.8	21.4699	42.94	64.41	85.88
.9	21.5188	43.04	64.56	86.08
88.0	21.5678	43.14	64.70	86.27
.1	21.6169	43.23	64.85	86.47
.2	21.6660	43.33	65.00	86.66
.3	21.7151	43.43	65.15	86.86
.4	21.7643	43.53	65.29	87.06
.5	21.8136	43.63	65.44	87.25
.6	21.8629	43.73	65.59	87.45
.7	21.9123	43.82	65.74	87.65
.8	21.9617	43.92	65.89	87.85
.9	22.0112	44.02	66.03	88.04
89.0	22.0608	44.12	66.18	88.24
.1	22.1104	44.22	66.33	88.44
.2	22.1600	44.32	66.48	88.64
.3	22.2098	44.42	66.63	88.84
.4	22.2595	44.52	66.78	89.04
.5	22.3093	44.62	66.93	89.24
.6	22.3592	44.72	67.08	89.44
.7	22.4092	44.82	67.23	89.64
.8	22.4592	44.92	67.38	89.84
.9	22.5092	45.02	67.53	90.04

DEPTH.				
5	6	7	8	9
105.40	126.48	147.[illegible]	168.64	189.72
105.65	126.77	147.90	169.03	190.16
105.89	127.06	148.24	169.42	190.59
106.13	127.36	148.58	169.81	191.03
106.38	127.65	148.93	170.20	191.48
106.62	127.94	149.26	170.58	191.91
106.86	128.23	149.60	170.98	192.35
107.11	128.53	149.95	171.37	192.79
107.35	128.82	150.29	171.76	193.23
107.60	129.11	150.63	172.15	193.67
107.84	129.41	150.98	172.54	194.11
108.09	129.70	151.32	172.94	194.55
108.33	130.00	151.66	173.33	194.99
108.58	130.29	152.01	173.72	195.44
108.82	130.58	152.35	174.11	195.88
109.07	130.88	152.69	174.50	196.32
109.32	131.18	153.04	174.90	196.77
109.56	131.47	153.38	175.30	197.21
109.81	131.77	153.73	175.70	197.66
110.06	132.07	154.08	176.09	198.10
110.31	132.37	154.43	176.49	198.55
110.55	132.66	154.77	176.88	198.99
110.80	132.96	155.12	177.28	199.44
111.05	133.26	155.47	177.68	199.89
111.30	133.55	155.81	178.07	200.33
111.55	133.85	156.16	178.47	200.78
111.80	134.15	156.51	178.87	201.23
112.05	134.45	156.86	179.27	201.68
112.30	134.75	157.21	179.67	202.13
112.55	135.05	157.56	180.07	202.58

Diam. in Inches.	DEPTH. 1	2	3	4
90.0	22.5593	45.12	67.68	90.24
.1	22.6095	45.22	67.83	90.44
.2	22.6597	45.32	67.98	90.64
.3	22.7100	45.42	68.13	90.84
.4	22.7603	45.52	68.28	91.04
.5	22.8107	45.62	68.43	91.24
.6	22.8611	45.72	68.58	91.44
.7	22.9116	45.82	68.73	91.64
.8	22.9621	45.92	68.89	91.85
.9	23.0128	46.03	69.04	92.05
91.0	23.0634	46.13	69.19	92.25
.1	23.1141	46.23	69.34	92.46
.2	23.1649	46.33	69.50	92.66
.3	23.2157	46.43	69.65	92.86
.4	23.2666	46.53	69.80	93.06
.5	23.3176	46.63	69.95	93.27
.6	23.3685	46.74	70.10	93.47
.7	23.4196	46.84	70.26	93.68
.8	23.4707	46.94	70.41	93.88
.9	23.5219	47.04	70.57	94.09
92.0	23.5731	47.15	70.72	94.29
.1	23.6244	47.25	70.87	94.50
.2	23.6757	47.35	71.03	94.70
.3	23.7271	47.45	71.18	94.91
.4	23.7785	47.56	71.33	95.11
.5	23.8300	47.66	71.49	95.32
.6	23.8816	47.76	71.64	95.52
.7	23.9332	47.87	71.80	95.73
.8	23.9848	47.97	71.96	95.94
.9	24.0366	48.07	72.11	96.14

DEPTH.				
5	6	7	8	9
112.80	135.35	157.91	180.47	203.03
113.05	135.65	158.26	180.87	203.48
113.30	135.96	158.62	181.28	203.94
113.55	136.26	158.97	181.68	204.39
113.80	136.56	159.32	182.08	204.84
114.05	136.86	159.67	182.48	205.29
114.31	137.17	160.03	182.89	205.75
114.56	137.47	160.38	183.29	206.20
114.81	137.77	160.73	183.70	206.66
115.07	138.08	161.09	184.10	207.12
115.32	138.38	161.44	184.50	207.57
115.57	138.68	161.80	184.91	208.03
115.83	138.99	162.16	185.32	208.49
116.08	139.30	162.51	185.73	208.94
116.33	139.60	162.86	186.13	209.39
116.59	139.90	163.22	186.54	209.85
116.84	140.21	163.58	186.94	210.31
117.10	140.51	163.93	187.35	210.77
117.36	140.83	164.30	187.77	211.24
117.61	141.13	164.65	188.18	211.70
117.87	141.44	165.01	188.58	212.16
118.12	141.74	165.37	188.99	212.62
118.38	142.05	165.73	189.40	213.08
118.64	142.36	166.09	189.82	213.54
118.89	142.67	166.45	190.22	214.00
119.15	142.98	166.81	190.64	214.47
119.41	143.29	167.17	191.05	214.93
119.67	143.60	167.53	191.46	215.40
119.93	143.91	167.90	191.88	215.87
120.18	144.22	168.25	192.29	216.32

Diam. in Inches.	DEPTH. 1	2	3	4	5
93.0	24.0883	48.18	72.26	96.39	120.
.1	24.1402	48.28	72.42	96.56	120.
.2	24.1920	48.38	72.58	96.77	120.
.3	24.2440	48.49	72.73	96.98	121.
.4	24.2960	48.59	72.89	97.18	121.
.5	24.3480	48.70	73.04	97.39	121
.6	24.4001	48.80	73.20	97.60	122
.7	24.4523	48.90	73.36	97.81	122
.8	24.5045	49.01	73.51	98.02	122
.9	24.5568	49.11	73.67	98.23	122
94.0	24.6091	49.22	73.83	98.44	[illegible]
.1	24.6615	49.32	73.98	98.64	[illegible]
.2	24.7140	49.43	74.14	98.86	[illegible]
.3	24.7665	49.53	74.30	99.06	[illegible]
.4	24.8190	49.64	74.46	99.28	[illegible]
.5	24.8716	49.74	74.61	99.48	[illegible]
.6	24.9243	49.85	74.77	99.70	[illegible]
.7	24.9770	49.95	74.93	99.91	[illegible]
.8	25.0298	50.06	75.09	100.12	[illegible]
.9	25.0826	50.16	75.25	100.33	[illegible]
95.0	25.1355	50.27	75.41	100.54	[illegible]
.1	25.1885	50.38	75.56	100.75	[illegible]
.2	25.2415	50.48	75.72	100.96	[illegible]
.3	25.2945	50.59	75.88	101.18	[illegible]
.4	25.3476	50.69	76.04	101.39	[illegible]
.5	25.4008	50.80	76.20	101.60	[illegible]
.6	25.4540	50.91	76.36	101.82	[illegible]
.7	25.5073	51.01	76.52	102.03	[illegible]
.8	25.5606	51.12	76.68	102.24	[illegible]
.9	25.6140	51.22	76.84	102.46	[illegible]

DEPTH.				
5	6	7	8	9
120.44	144.53	168.61	192.70	216.79
120.70	144.84	168.98	193.12	217.26
120.96	145.15	169.34	193.54	217.73
121.22	145.46	169.70	193.95	218.20
121.48	145.78	170.07	194.37	218.66
121.74	146.09	170.43	194.78	219.13
122.00	146.40	170.80	195.20	219.60
122.26	146.71	171.16	195.62	220.07
122.52	147.02	171.52	196.03	220.54
122.79	147.34	171.89	196.46	221.01
123.05	147.65	172.26	196.87	221.48
123.31	147.97	172.62	197.29	221.95
123.57	148.28	172.99	197.71	222.43
123.83	148.60	173.36	198.13	222.89
124.10	148.91	173.73	198.55	223.37
124.36	149.23	174.09	198.97	223.84
124.62	149.54	174.46	199.39	224.32
124.89	149.86	174.83	199.82	224.79
125.15	150.18	175.21	200.24	225.27
125.41	150.49	175.57	200.66	225.74
125.68	150.81	175.94	201.08	226.22
125.94	151.13	176.31	201.50	226.69
126.21	151.45	176.68	201.93	227.17
126.47	151.76	177.05	202.35	227.65
126.74	152.08	177.42	202.78	228.12
127.01	152.41	177.80	203.21	228.61
127.27	152.72	178.17	203.63	229.09
127.54	153.04	178.54	204.06	229.56
127.80	153.36	178.92	204.48	230.04
128.07	153.68	179.29	204.91	230.53

Diam in Inches.	DEPTH, 1	2	3	4
96.0	25.6675	51.33	77.00	102.
.1	25.7210	51.44	77.16	102.
.2	25.7745	51.55	77.32	103.
.3	25.8282	51.66	77.48	103.
.4	25.8818	51.76	77.65	103.
.5	25.9355	51.87	77.81	103.
.6	25.9893	51.98	77.97	103.
.7	26.0432	52.09	78.13	104.
.8	26.0971	52.19	78.29	104.
.9	26.1510	52.30	78.45	104.
97.0	26.2050	52.41	78.62	104.
.1	26.2591	52.52	78.78	105.
.2	26.3132	52.63	78.94	105.
.3	26.3673	52.73	79.10	105.
.4	26.4216	52.84	79.26	105.
.5	26.4759	52.95	79.43	105.
.6	26.5302	53.06	79.59	106.
.7	26.5846	53.17	79.75	106.
.8	26.6390	53.28	79.92	106
.9	26.6935	53.39	80.08	106.
98.0	26.7481	53.50	80.24	106.
.1	26.8027	53.61	80.41	107.
.2	26.8574	53.71	80.57	107.
.3	26.9121	53.82	80.74	107.
.4	26.9669	53.93	80.90	107.
.5	27.0217	54.04	81.07	108.
.6	27.0766	54.15	81.23	108.3
.7	27.1316	54.26	81.39	108.5
.8	27.1866	54.37	81.56	108.7
.9	27.2416	54.48	81.72	108.9

DEPTH.				
5	6	7	8	9
8.34	154.00	179.67	205.34	231.00
8.61	154.33	180.05	205.77	231.49
8.87	154.64	180.42	206.19	231.97
9.14	154.97	180.80	206.62	232.45
9.41	155.29	181.17	207.06	232.94
9.68	155.61	181.55	207.48	233.42
9.95	155.93	181.92	207.91	233.90
0.22	156.26	182.30	208.34	234.39
0.49	156.58	182.68	208.78	234.87
0.76	156.91	183.06	209.21	235.36
1.03	157.23	183.44	209.64	235.85
1.30	157.55	183.81	210.07	236.33
1.57	157.88	184.19	210.50	236.82
1.84	158.20	184.57	210.94	237.30
2.11	158.53	184.95	211.37	237.79
2.38	158.86	185.33	211.81	238.28
2.65	159.18	185.71	212.24	238.77
2.92	159.50	186.09	212.67	239.26
3.20	159.83	186.47	213.11	239.75
3.46	160.16	186.85	213.54	240.24
3.74	160.49	187.24	213.98	240.73
4.02	160.82	187.62	214.42	241.23
4.29	161.14	188.00	214.86	241.71
4.56	161.47	188.38	215.30	242.21
4.84	161.80	188.77	215.74	242.70
35.11	162.13	189.15	216.18	243.20
35.38	162.46	189.53	216.61	243.68
35.66	162.79	189.92	217.05	244.18
35.93	163.12	190.30	217.49	244.67
36.21	163.45	190.69	217.93	245.17

Diam. in Inches.	DEPTH. 1	2	3	4
99.0	27.2968	54.59	81.89	109.
.1	27.3519	54.70	82.06	109.
.2	27.4072	54.81	82.22	109.
.3	27.4625	54.92	82.39	109.
.4	27.5178	55.04	82.55	110.
.5	27.5732	55.15	82.72	110.
.6	27.6286	55.26	82.88	110.
.7	27.6841	55.37	83.05	110.
.8	27.7397	55.48	83.22	110.
.9	27.7953	55.59	83.39	111.
100.0	27.8510	55.70	83.55	111.
.1	27.9067	55.81	83.72	111.
.2	27.9625	55.92	83.89	111.
.3	28.0184	56.04	84.05	112.
.4	28.0743	56.15	84.22	112.
.5	28.1302	56.26	84.39	112.
.6	28.1862	56.37	84.56	112.
.7	28.2423	56.48	84.73	112.
.8	28.2984	56.60	84.89	113.
.9	28.3546	56.71	85.06	113.
101.0	28.4108	56.82	85.23	113.
.1	28.4671	56.93	85.40	113.
.2	28.5234	57.05	85.57	114.
.3	28.5798	57.16	85.74	114.
.4	28.6363	57.27	85.91	114.
.5	28.6928	57.39	86.08	114.7
.6	28.7494	57.50	86.25	115.
.7	28.8060	57.61	86.42	115.2
.8	28.8627	57.73	86.59	115.4
.9	28.9194	57.84	86.76	115.6

DEPTH.				
5	6	7	8	9
153.53	184.24	214.94	245.65	276.35
153.82	184.58	215.35	246.11	276.88
154.12	184.94	215.76	246.58	277.41
154.41	185.29	216.17	247.05	277.93
154.70	185.64	216.58	247.52	278.46
155.00	185.99	216.99	247.99	278.99
155.29	186.35	217.41	248.46	279.52
155.58	186.70	217.81	248.93	280.04
155.88	187.05	218.23	249.40	280.58
156.17	187.40	218.64	249.87	281.11
156.47	187.75	219.05	250.34	281.64
156.76	188.11	219.46	250.82	282.17
157.06	188.47	219.88	251.29	282.70
157.36	188.83	220.30	251.77	283.24
157.65	189.18	220.71	252.24	283.77
157.95	189.53	221.12	252.71	284.30
158.25	189.89	221.54	253.19	284.84
158.54	190.25	221.96	253.66	285.37
158.84	190.60	222.37	254.14	285.90
159.14	190.96	222.79	254.62	286.44
159.43	191.32	223.20	255.09	286.97
159.73	191.68	223.62	255.57	287.51
160.03	192.04	224.04	256.05	288.05
160.33	192.40	224.46	256.53	288.59
160.63	192.75	224.88	257.00	289.13
160.93	193.11	225.30	257.48	289.67
161.23	193.47	225.72	257.96	290.21
161.53	193.83	226.14	258.44	290.75
161.83	194.19	226.56	258.92	291.29
162.13	194.55	226.98	259.40	291.83

Diam. in Inches.	DEPTH.			
	1	2	3	4
108.0	32.4854	64.97	97.46	129.94
.1	32.5456	65.09	97.64	130.18
.2	32.6058	65.21	97.82	130.42
.3	32.6661	65.33	98.00	130.66
.4	32.7265	65.45	98.18	130.90
.5	32.7869	65.57	98.36	131.15
.6	32.8474	65.69	98.54	131.39
.7	32.9079	65.82	98.72	131.63
.8	32.9685	65.94	98.90	131.87
.9	33.0291	66.06	99.09	132.12
109.0	33.0898	66.18	99.27	132.36
.1	33.1505	66.30	99.45	132.60
.2	33.2115	66.42	99.63	132.84
.3	33.2722	66.54	99.82	133.09
.4	33.3331	66.67	100.00	133.33
.5	33.3940	66.79	100.18	133.58
.6	33.4551	66.91	100.37	133.82
.7	33.5161	67.03	100.55	134.06
.8	33.5773	67.16	100.73	134.31
.9	33.6385	67.28	100.92	134.56
110.0	33.6997	67.40	101.10	134.80
.1	33.7610	67.52	101.28	135.04
.2	33.8224	67.64	101.47	135.29
.3	33.8838	67.77	101.65	135.54
.4	33.9452	67.89	101.84	135.78
.5	34.0068	68.01	102.02	136.03
.6	34.0683	68.14	102.20	136.27
.7	34.1300	68.26	102.39	136.52
.8	34.1917	68.38	102.58	136.77
.9	34.2534	68.51	102.76	137.01

DEPTH.				
5	6	7	8	9
136.49	163.78	191.08	218.38	245.67
136.76	164.11	191.46	218.82	246.17
137.04	164.44	191.85	219.26	246.66
137.31	164.77	192.23	219.70	247.16
137.59	165.11	192.63	220.14	247.66
137.87	165.44	193.01	220.58	248.16
138.14	165.77	193.40	221.02	248.65
138.42	166.10	193.79	221.47	249.16
138.70	166.44	194.18	221.92	249.66
138.98	166.77	194.57	222.36	250.16
139.26	167.11	194.96	222.81	250.66
139.54	167.44	195.35	223.26	251.16
139.81	167.77	195.73	223.70	251.66
140.09	168.11	196.13	224.14	252.16
140.37	168.44	196.52	224.59	252.67
140.55	168.78	196.91	225.04	253.17
140.93	169.12	197.30	225.49	253.67
141.21	169.45	197.69	225.94	254.18
141.49	169.79	198.09	226.38	254.68
141.77	170.12	198.48	226.83	255.19
142.06	170.47	198.88	227.29	255.70
142.34	170.80	199.27	227.74	256.20
142.62	170.14	199.66	228.18	256.71
142.90	171.48	200.06	228.64	257.22
143.18	171.82	200.45	229.09	257.72
143.47	172.16	200.85	229.54	258.24
143.75	172.49	201.24	229.99	258.74
144.03	172.84	201.64	230.45	259.25
144.32	173.18	202.04	230.90	259.77
144.60	173.51	202.43	231.35	260.27

Diam. in Inches.	DEPTH. 1	2	3	4
102.0	28.9762	57.95	86.93	115.90
.1	29.0330	58.07	87.10	116.13
.2	29.0899	58.18	87.27	116.36
.3	29.1469	58.29	87.44	116.59
.4	29.2039	58.41	87.61	116.82
.5	29.2610	58.52	87.78	117.04
.6	29.3181	58.64	87.95	117.27
.7	29.3753	58.75	88.13	117.50
.8	29.4325	58.86	88.30	117.73
.9	29.4898	58.98	88.47	117.96
103.0	29.5471	59.09	88.64	118.19
.1	29.6045	59.21	88.81	118.42
.2	29.6620	59.32	88.99	118.65
.3	29.7195	59.44	89.16	118.88
.4	29.7771	59.55	89.33	119.11
.5	29.8347	59.67	89.51	119.34
.6	29.8924	59.78	89.68	119.57
.7	29.9501	59.90	89.85	119.80
.8	30.0079	60.02	90.02	120.03
.9	30.0657	60.13	90.20	120.26
104.0	30.1236	60.25	90.37	120.49
.1	30.1816	60.36	90.54	120.72
.2	30.2396	60.48	90.72	120.96
.3	30.2977	60.60	90.89	121.19
.4	30.3558	60.71	91.07	121.42
.5	30.4140	60.83	91.24	121.66
.6	30.4722	60.94	91.42	121.89
.7	30.5305	61.06	91.59	122.12
.8	30.5889	61.18	91.77	122.36
.9	30.6473	61.29	91.94	122.59

DEPTH				
5	6	7	8	9
144.88	173.86	202.83	231.81	260.78
145.17	174.20	203.23	232.26	261.30
145.45	174.54	203.63	232.72	261.81
145.74	174.88	204.03	233.18	262.32
146.02	175.22	204.43	233.63	262.84
146.31	175.57	204.83	234.09	263.35
146.59	175.91	205.23	234.54	263.85
146.88	176.25	205.63	235.00	264.38
147.16	176.59	206.02	235.46	264.89
147.45	176.94	206.43	235.92	265.41
147.74	177.28	206.83	236.38	265.92
148.02	177.62	207.23	236.83	266.44
148.31	177.97	207.63	237.30	266.96
148.60	178.31	208.03	237.75	267.47
148.89	178.66	208.44	238.22	267.99
149.18	179.01	208.85	238.68	268.52
149.46	179.35	209.24	239.14	269.03
149.75	179.70	209.65	239.60	269.55
150.04	180.05	210.06	240.06	270.07
150.33	180.40	210.46	240.53	270.59
150.62	180.74	210.86	240.98	271.11
150.91	181.09	211.27	241.45	271.63
151.20	181.43	211.67	241.91	272.15
151.49	181.79	212.09	242.38	272.68
151.78	182.14	212.49	242.85	273.20
152.07	182.48	212.90	243.31	273.73
152.36	182.83	213.30	243.78	274.25
152.65	183.18	213.71	244.24	274.77
152.95	183.53	214.12	244.71	275.30
153.24	183.88	214.53	245.18	275.82

Diam. in Inches.	DEPTH. 1	2	3	4
105.0	30.7057	61.41	92.12	122.82
.1	30.7642	61.53	92.29	123.06
.2	30.8228	61.65	92.47	123.29
.3	30.8814	61.76	92.64	123.52
.4	30.9401	61.88	92.82	123.76
.5	30.9989	62.00	93.00	124.00
.6	31.0577	62.12	93.17	124.23
.7	31.1165	62.23	93.35	124.46
.8	31.1754	62.35	93.53	124.7
.9	31.2344	62.47	93.70	124.9
106.0	31.2934	62.59	93.88	125.1
.1	31.3525	62.70	94.06	125.4
.2	31.4116	62.82	94.23	125.6
.3	31.4708	62.94	94.41	125.8
.4	31.5300	63.06	94.59	126.1
.5	31.5893	63.18	94.77	126.3
.6	31.6487	63.30	94.95	126.6
.7	31.7081	63.42	95.12	126.8
.8	31.7675	63.53	95.30	127.0
.9	31.8270	63.65	95.48	127.3
107.0	31.8866	63.77	95.66	127.5
.1	31.9462	63.89	95.84	127.7
.2	32.0059	64.01	96.02	128.0
.3	32.0657	64.13	96.20	128.2
.4	32.1255	64.25	96.38	128.5
.5	32.1853	64.37	96.56	128.7
.6	32.2452	64.49	96.74	128.9
.7	32.3052	64.61	96.92	129.2
.8	32.3652	64.73	97.10	129.4
.9	32.4252	64.85	97.28	129.7

DEPTH.				
5	6	7	8	9
171.58	205.89	240.21	274.52	308.84
171.89	206.26	240.64	275.02	309.39
172.20	206.63	241.07	275.51	309.95
172.51	207.01	241.51	276.01	310.51
172.82	207.38	241.94	276.50	311.07
173.13	207.75	242.38	277.00	311.63
173.44	208.12	242.81	277.50	312.18
173.75	208.49	243.24	277.99	312.74
174.06	208.87	243.68	278.49	313.30
174.37	209.24	244.12	278.99	313.87
174.68	209.62	244.55	279.49	314.42
175.00	209.99	244.99	279.99	314.99
175.31	210.37	245.43	280.49	315.55
175.62	210.74	245.87	280.99	316.12
175.93	211.12	246.30	281.49	316.67
176.25	211.49	246.84	281.99	317.24
176.56	211.87	247.18	282.49	317.80
176.87	212.24	247.62	282.99	318.37
177.19	212.62	248.06	283.50	318.93
177.50	213.00	248.50	284.00	319.50
177.82	213.38	248.94	284.50	320.07
178.13	213.76	249.38	285.01	320.63
178.45	214.13	249.82	285.51	321.20
178.76	214.51	250.26	286.02	321.77
179.08	214.89	250.71	286.52	322.34
179.39	215.27	251.15	287.02	322.90
179.71	215.65	251.59	287.53	323.47
180.03	216.03	252.04	288.04	324.05
180.34	216.41	252.48	288.54	324.61
180.66	216.79	252.92	289.06	325.19

Diam. in Inches.	DEPTH. 1	2	3	4
114.0	36.1952	72.39	108.59	144.78
.1	36.2587	72.52	108.78	145.04
.2	36.3223	72.64	108.97	145.29
.3	36.3859	72.77	109.16	145.54
.4	36.4495	72.90	109.35	145.80
.5	36.5134	73.03	109.54	146.05
.6	36.5772	73.15	109.73	146.31
.7	36.6410	73.28	109.92	146.56
.8	36.7049	73.41	110.12	146.82
.9	36.7689	73.54	110.31	147.08
115.0	36.8329	73.67	110.50	147.33
.1	36.8970	73.79	110.69	147.59
.2	36.9612	73.92	110.88	147.84
.3	37.0254	74.05	111.08	148.10
.4	37.0895	74.18	111.27	148.36
.5	37.1539	74.31	111.46	148.62
.6	37.2183	74.44	111.66	148.87
.7	37.2827	74.57	111.85	149.13
.8	37.3472	74.69	112.04	149.39
.9	37.4117	74.82	112.24	149.65
116.0	37.4763	74.95	112.43	149.91
.1	37.5409	75.08	112.62	150.16
.2	37.6056	75.21	112.82	150.42
.3	37.6704	75.34	113.01	150.68
.4	37.7352	75.47	113.21	150.94
.5	37.8001	75.60	113.40	151.20
.6	37.8650	75.73	113.60	151.46
.7	37.9300	75.86	113.79	151.72
.8	37.9950	75.99	113.99	151.98
.9	38.0601	76.12	114.18	152.24

DEPTH.				
5	6	7	8	9
180.98	217.17	253.36	289.56	325.76
181.30	217.55	253.81	290.07	326.33
181.61	217.93	254.25	290.58	326.90
181.93	218.32	254.70	291.09	327.47
182.25	218.69	255.14	291.59	328.04
182.57	219.08	255.59	292.10	328.62
182.89	219.46	256.04	292.62	329.19
183.21	219.85	256.49	293.13	329.77
183.53	220.23	256.94	293.64	330.35
183.85	220.61	257.38	294.15	330.92
184.17	221.06	257.83	294.66	331.50
184.49	221.38	258.28	295.18	332.07
184.81	221.77	258.73	295.69	332.65
185.13	222.15	259.18	296.20	333.23
185.45	222.53	259.62	296.71	333.80
185.78	222.92	260.08	297.23	334.39
186.09	223.31	260.53	297.74	334.96
186.42	223.70	260.98	298.27	335.55
186.74	224.08	261.43	298.78	336.12
187.06	224.47	261.88	299.30	336.71
187.38	224.86	262.33	299.81	337.29
187.71	225.25	262.79	300.33	337.87
188.03	225.63	263.24	300.84	338.45
188.35	226.02	263.69	301.36	339.03
188.68	226.41	264.15	301.88	339.62
189.00	226.80	264.60	302.40	340.20
189.33	227.19	265.06	302.92	340.79
189.65	227.58	265.51	303.44	341.37
189.98	227.97	265.97	303.96	341.96
190.30	228.36	266.42	304.48	342.54

Diam. in Inches.	DEPTH.			
	1	2	3	4
117.0	38.1252	76.25	114.38	152.5
.1	38.1904	76.38	114.57	152.7
.2	38.2557	76.51	114.77	153.0
.3	38.3210	76.64	114.96	153.2
.4	38.3864	76.77	115.16	153.5
.5	38.4518	76.90	115.36	153.8
.6	38.5173	77.03	115.55	154.0
.7	38.5828	77.17	115.75	154.3
.8	38.6484	77.30	115.95	154.5
.9	38.7140	77.43	116.14	154.8
118.0	38.7797	77.56	116.34	155.1
.1	38.8455	77.69	116.54	155.3
.2	38.9113	77.82	116.73	155.6
.3	38.9772	77.95	116.93	155.
.4	39.0431	78.09	117.13	156.
.5	39.1091	78.22	117.33	156.
.6	39.1751	78.35	117.53	156.
.7	39.2412	78.48	117.72	156.
.8	39.3073	78.61	117.92	157.
.9	39.3735	78.75	118.12	157.
119.0	39.4398	78.88	118.32	157.
.1	39.5061	79.01	118.52	158.
.2	39.5725	79.14	118.72	158.
.3	39.6389	79.28	118.92	158.
.4	39.7054	79.41	119.12	158.
.5	39.7719	79.54	119.32	159.
.6	39.8385	79.68	119.51	159.
.7	39.9052	79.81	119.72	159.
.8	39.9719	79.94	119.92	159.
.9	40.0386	80.08	120.11	160.

DEPTH.				
5	6	7	8	9
162.43	194.91	227.40	259.88	292.37
162.73	195.27	227.82	260.36	292.91
163.03	195.63	228.24	260.85	293.45
163.33	196.00	228.66	261.33	293.99
163.63	196.36	229.08	261.81	294.53
163.94	196.72	229.51	262.30	295.08
164.24	197.08	229.93	262.78	295.62
164.54	197.45	230.36	263.26	296.17
164.84	197.80	230.78	263.74	296.71
165.15	198.17	231.20	264.23	297.26
165.45	198.54	231.63	264.72	297.81
165.75	198.90	232.05	265.20	298.35
166.06	199.27	232.48	265.69	298.90
166.36	199.63	232.90	266.18	299.45
166.67	200.00	233.33	266.66	300.00
166.97	200.36	233.76	267.15	300.55
167.28	200.73	234.19	267.64	301.10
167.58	201.10	234.61	268.13	301.64
167.89	201.47	235.05	268.62	302.20
168.20	201.83	235.47	269.11	302.75
168.50	202.20	235.90	269.60	303.30
168.81	202.57	236.33	270.09	303.85
169.11	202.93	236.75	270.58	304.40
169.42	203.30	237.19	271.07	304.96
169.73	203.67	237.62	271.56	305.51
170.04	204.04	238.05	272.06	306.06
170.34	204.41	238.48	272.54	306.61
170.65	204.78	238.91	273.04	307.17
170.96	205.15	239.34	273.54	307.73
171.27	205.52	239.77	274.02	308.28

Diam. in Inches.	DEPTH.			
	1	2	3	4
111.0	34.3152	68.63	102.95	137.2
.1	34.3771	68.75	103.13	137.5
.2	34.4390	68 88	103.32	137.7
.3	34.5010	69.00	103.50	138.0
.4	34.5630	69.13	103.69	138.2
.5	34.6251	69.25	103.88	138.5
.6	34.6872	69.37	104.06	138.7
.7	34.7494	69.50	104.25	139.0
.8	34.8116	69.62	104.43	139.2
.9	34.8739	69.75	104.62	139.5
112.0	34.9363	69.87	104.81	139.7
.1	34.9987	70.00	105.00	140.0
.2	35.0612	70.12	105.18	140.2
.3	35.1237	70.25	105.37	140.5
.4	35.1863	70.37	105.56	140.7
.5	35.2489	70.50	105.75	141.0
.6	35.3116	70.62	105.93	141.2
.7	35.3744	70.75	106.12	141.5
.8	35.4372	70.87	106.31	141.7
.9	35.5000	71.00	106.50	142.0
113.0	35.5629	71.13	106.69	142.2
.1	35.6259	71.25	106.88	142.5
.2	35.6889	71.38	107.07	142.7
.3	35.7520	71.50	107.26	143.0
.4	35.8152	71.63	107.45	143.2
.5	35.8784	71.76	107.64	143.5
.6	35.9416	71.88	107.82	143.7
.7	36.0049	72.01	108.02	144.0
.8	36.0683	72.14	108.21	144.2
.9	36.1317	72.26	108.40	144.5

DEPTH.				
5	6	7	8	9
190.63	228.75	266.88	305.00	343.13
190.95	229.14	267.33	305.52	343.71
191.28	229.54	267.79	306.05	344.30
191.61	229.93	268.25	306.57	344.89
191.93	230.32	268.70	307.09	345.47
192.26	230.71	269.16	307.62	346.07
192.59	231.10	269.62	308.14	346.65
192.92	231.50	270.08	308.66	347.25
193.24	231.89	270.54	309.18	347.83
193.57	232.28	271.00	309.71	348.43
193.90	232.68	271.46	310.24	349.02
194.23	233.07	271.92	310.76	349.61
194.56	233.47	272.38	311.29	350.20
194.89	233.86	272.84	311.82	350.79
195.22	234.26	273.30	312.34	351.39
195.55	234.65	273.76	312.87	351.98
195.88	235.06	274.23	313.40	352.58
196.21	235.45	274.69	313.93	353.17
196.54	235.84	275.15	314.46	353.76
196.87	236.24	275.61	314.98	354.36
197.20	236.64	276.08	315.52	354.96
197.53	237.04	276.54	316.05	355.55
197.86	237.43	277.01	316.58	356.15
198.20	237.83	277.47	317.11	356.75
198.53	238.23	277.94	317.64	357.35
198.86	238.63	278.40	318.18	357.95
199.19	239.03	278.87	318.70	358.54
199.53	239.43	279.34	319.24	359.15
199.86	239.83	279.80	319.78	359.75
200.19	240.23	280.27	320.30	360.24

Diam. in Inches.	DEPTH. 1	2	3	4
120.0	40.1054	80.21	120.32	160.42
.1	40.1723	80.34	120.52	160.69
.2	40.2392	80.48	120.72	160.96
.3	40.3062	80.61	120.92	161.22
.4	40.3733	80.75	121.12	161.49
.5	40.4403	80.88	121.32	161.76
.6	40.5075	81.01	121.52	162.03
.7	40.5747	81.15	121.73	162.30
.8	40.6420	81.28	121.93	162.57
.9	40.7093	81.42	122.13	162.84
121.0	40.7766	81.55	122.33	163.10
.1	40.8441	81.69	122.53	163.38
.2	40.9116	81.82	122.74	163.64
.3	40.9791	81.95	122.94	163.92
.4	41.0467	82.09	123.14	164.19
.5	41.1143	82.23	123.34	164.46
.6	41.1820	82.36	123.55	164.73
.7	41.2498	82.50	123.75	165.00
.8	41.3176	82.63	123.95	165.27
.9	41.3855	82.77	124.16	165.54
122.0	41.4534	82.91	124.36	165.81
.1	41.5214	83.04	124.56	166.08
.2	41.5895	83.18	124.77	166.36
.3	41.6575	83.31	124.97	166.63
.4	41.7257	83.45	125.18	166.90
.5	41.7939	83.59	125.38	167.18
.6	41.8622	83.72	125.59	167.45
.7	41.9305	83.86	125.79	167.72
.8	41.9989	84.00	126.00	168.00
.9	42.0673	84.13	126.20	168.27

DEPTH.				
5	6	7	8	9
200.53	240.53	280.74	320.84	360.95
200.86	241.03	281.20	321.38	361.55
201.20	241.43	281.67	321.91	362.15
201.53	241.84	282.14	322.45	362.75
201.87	242.24	282.61	322.98	363.36
202.20	242.54	283.08	323.52	363.95
202.54	243.04	283.55	324.06	364.56
202.88	243.45	284.02	324.60	36[illegible].[illegible]8
203.21	243.85	284.49	325.14	365.7[illegible]
203.55	244.25	284.96	325.67	366.38
203.88	244.66	285.43	326.21	366.98
204.22	245.06	285.91	326.75	367.60
204.56	245.47	286.38	327.30	368.21
204.90	245.87	286.85	327.83	368.81
205.24	246.28	287.33	328.38	369.42
205.57	246.68	287.80	328.91	370.03
205.91	247.09	288.27	329.46	370.64
206.25	247.50	288.75	330.00	371.25
206.59	247.90	289.22	330.54	371.85
206.93	248.31	289.70	331.08	372.47
207.27	248.72	290.17	331.62	373.08
207.61	249.13	290.65	332.17	373.69
207.95	249.53	291.12	332.71	374.30
208.29	249.94	291.60	333.26	374.91
208.63	250.36	292.08	333.81	375.53
208.97	250.76	292.56	334.35	376.15
209.31	251.17	293.03	334.90	376.76
209.65	251.58	293.51	335.44	377.37
210.00	251.99	293.99	335.99	377.99
210.34	252.40	294.47	336.54	378.60

Diam. in Inches.	DEPTH. 1	2	3	4
123.0	42.1358	84.27	126.41	168.55
.1	42.2043	84.41	126.61	168.82
.2	42.2729	84.55	126.82	169.09
.3	42.3416	84.68	127.02	169.36
.4	42.4103	84.82	127.23	169.64
.5	42.4790	84.96	127.44	169.92
.6	42.5479	85.10	127.64	170.19
.7	42.6167	85.23	127.85	170.47
.8	42.6857	85.37	128.06	170.74
.9	42.7547	85.51	128.27	171.02
124.0	42.8237	85.65	128.47	171.29
.1	42.8928	85.79	128.68	171.57
.2	42.9519	85.92	128.89	171.85
.3	43.0212	86.06	129.09	172.12
.4	43.1004	86.20	129.30	172.40
.5	43.1697	86.34	129.51	172.68
.6	43.2391	86.48	129.72	172.96
.7	43.3085	86.62	129.92	173.23
.8	43.3780	86.76	130.13	173.51
.9	43.4476	86.89	130.34	173.79
125.0	43.5172	87.03	130.55	174.07
.1	43.5868	87.17	130.76	174.35
.2	43.6566	87.31	130.97	174.62
.3	43.7263	87.45	131.18	174.90
.4	43.7961	87.59	131.39	175.18
.5	43.8660	87.73	131.60	175.46
.6	43.9360	87.87	131.81	175.74
.7	44.0059	88.01	132.02	176.02
.8	44.0760	88.15	132.23	176.30
.9	44.1461	88.29	132.44	176.58

DEPTH.				
5	6	7	8	9
210.68	252.82	294.95	337.09	379.22
211.02	253.22	295.43	337.63	379.84
211.37	253.64	295.91	338.18	380.46
211.71	254.05	296.39	338.73	381.07
212.05	254.46	295.87	339.28	381.69
212.40	254.87	297.35	339.83	382.31
212.74	255.29	297.84	340.38	382.93
213.09	255.70	298.32	340.94	383.55
213.43	256.12	298.80	341.49	384.17
213.78	256.53	299.29	342.04	384.80
214.12	256.94	299.76	342.58	385.41
214.47	257.36	300.25	343.14	386.04
214.81	257.77	300.73	343.70	386.66
215.16	258.19	301.22	344.25	387.28
215.50	258.60	301.70	344.80	387.90
215.85	259.02	302.19	345.36	383.53
216.20	259.43	302.67	345.91	389.15
216.54	259.85	303.16	346.46	389.77
216.89	260.27	303.65	347.02	390.40
217.24	250.68	304.13	347.58	391.02
217.59	261.10	304.62	348.14	391.55
217.94	261.52	305.11	348.70	392.28
218.28	261.94	305.59	349.25	392.90
218.63	262.36	306.08	349.81	393.53
218.98	262.78	306.57	350.37	394.16
219.33	263.20	307.06	350.93	394.79
219.58	263.62	307.55	351.49	395.42
220.03	264.04	308.04	352.05	396.05
220.38	264.46	308.53	352.61	396.58
220.73	264.88	309.02	353.17	397.31

Diam. in Inches.	DEPTH. 1	2	3	4
126.0	44.2162	88.43	132.65	176.86
.1	44.2865	88.57	132.86	177.14
.2	44.3567	88.71	133.07	177.43
.3	44.4271	88.85	133.28	177.71
.4	44.4974	88.99	133.49	177.99
.5	44.5679	89.14	133.70	178.27
.6	44.6384	89.28	133.91	178.55
.7	44.7089	89.42	134.13	178.84
.8	44.7795	89.56	134.34	179.12
.9	44.8502	89.70	134.55	179.40
127.0	44.9209	89.84	134.76	179.68
.1	44.9916	89.98	134.98	179.97
.2	45.0625	90.12	135.19	180.25
.3	45.1334	90.27	135.40	180.53
.4	45.2043	90.41	135.61	180.82
.5	45.2753	90.55	135.83	181.10
.6	45.3463	90.69	136.04	181.38
.7	45.4174	90.83	136.25	181.67
.8	45.4886	90.98	136.46	181.95
.9	45.5598	91.12	136.68	182.24
128.0	45.6311	91.26	136.89	182.52
.1	45.7024	91.40	137.11	182.81
.2	45.7738	91.55	137.32	183.10
.3	45.8452	91.69	137.54	183.38
.4	45.9167	91.83	137.75	183.67
.5	45.9883	91.98	137.96	183.95
.6	46.0599	92.12	138.18	184.24
.7	46.1315	92.26	138.39	184.52
.8	46.2032	92.41	138.61	184.81
.9	46.2750	92.55	138.83	145.10

DEPTH.				
5	6	7	8	9
221.08	265.30	309.51	353.73	397.94
221.43	265.72	310.00	354.29	398.57
221.79	266.14	310.50	354.86	399.21
222.14	266.56	310.99	355.42	399.84
222.49	266.98	311.48	355.98	400.47
222.84	267.41	311.98	356.54	401.11
223.19	267.83	312.47	357.10	401.74
223.55	268.25	312.96	357.67	402.38
223.90	268.67	313.45	358.23	403.01
224.25	269.10	313.95	358.80	403.65
224.61	269.53	314.45	359.37	404.29
224.96	269.95	314.94	359.94	404.93
225.31	270.37	315.43	360.50	405.56
225.67	270.80	315.93	361.06	406.20
226.02	271.22	316.43	361.63	406.84
226.38	271.65	316.93	362.20	407.48
226.73	272.08	317.42	362.77	408.11
227.09	272.50	317.92	363.34	408.75
227.44	272.93	318.42	363.90	409.39
227.80	273.36	318.92	364.48	410.04
228.16	273.79	319.42	365.05	410.68
228.51	274.21	319.91	365.62	411.32
228.87	274.64	320.42	366.19	411.97
229.23	275.07	320.92	366.77	412.61
229.58	275.50	321.42	367.34	413.25
229.94	275.93	321.92	367.90	413.89
230.30	276.36	322.42	368.48	414.54
230.66	276.79	322.92	369.05	415.18
231.02	277.22	323.42	369.62	415.83
231.38	277.65	323.93	370.20	416.48

A Table of the Area's of Circles

Diam. in Inches.	DEPTH.			
	1	2	3	4
129.0	46.3468	92.69	139.04	185.39
.1	46.4187	92.84	139.26	185.68
.2	46.4907	92.98	139.47	185.96
.3	46.5627	93.13	139.69	186.25
.4	46.6347	93.27	139.91	186.54
.5	46.7068	93.41	140.12	186.83
.6	46.7790	93.56	140.34	187.12
.7	46.8512	93.70	140.55	187.40
.8	46.9235	93.85	140.77	187.69
.9	46.9958	93.99	140.99	187.98
130.0	47.0682	94.14	141.20	188.27
.1	47.1406	94.28	141.42	188.56
.2	47.2131	94.43	141.64	188.85
.3	47.2857	94.57	141.86	189.14
.4	47.3583	94.72	142.07	189.43
.5	47.4309	94.86	142.29	189.72
.6	47.5037	95.01	142.51	190.02
.7	47.5764	95.15	142.73	190.30
.8	47.6493	95.30	142.95	190.60
.9	47.7222	95.44	143.17	190.89
131.0	47.7951	95.59	143.39	191.18
.1	47.8681	95.74	143.60	191.47
.2	47.9412	95.88	143.82	191.76
.3	48.0143	96.03	144.04	192.06
.4	48.0874	96.17	144.26	192.35
.5	48.1605	96.32	144.48	192.64
.6	48.2339	96.47	144.70	192.94
.7	48.3073	96.61	144.92	193.23
.8	48.3806	96.76	145.14	193.52
.9	48.4541	96.91	145.36	193.82

DEPTH.				
5	6	7	8	9
231.74	278.08	324.43	370.78	417.12
232.10	278.51	324.93	371.35	417.77
232.46	278.95	325.44	371.93	418.42
232.82	279.38	325.94	372.50	419.07
233.18	279.81	326.45	373.08	419.72
233.54	280.24	326.95	373.66	420.36
233.90	280.67	327.45	374.23	421.01
234.26	281.11	327.96	374.81	421.66
234.62	281.54	328.46	375.38	422.31
234.98	281.98	328.97	375.97	422.96
235.34	282.41	329.48	376.54	423.61
235.70	282.84	329.98	377.12	424.26
236.07	283.28	330.49	377.70	424.92
236.43	283.72	331.00	378.29	425.57
236.79	284.15	331.51	378.86	426.22
237.16	284.59	332.02	379.45	426.88
237.52	285.02	332.53	380.03	427.54
237.88	285.46	333.03	380.61	428.18
238.25	285.89	333.54	381.19	428.84
238.61	286.33	334.95	381.78	429.50
238.98	286.77	334.57	382.36	430.16
239.34	287.21	335.08	382.94	430.81
239.71	287.65	335.59	383.53	431.47
240.07	288.08	336.10	384.11	432.13
240.44	288.52	336.61	384.70	432.78
240.80	288.96	337.12	385.28	433.44
241.17	289.40	337.64	385.87	434.11
241.54	289.84	338.15	386.46	434.76
241.90	290.28	338.66	387.04	435.42
242.27	290.72	339.18	387.63	436.09

Diam. in Inches.	DEPTH. 1	2	3	4
132.0	48.5276	97.05	145.58	194.11
.1	48.6011	97.20	145.80	194.40
.2	48.6747	97.35	146.03	194.70
.3	48.7484	97.50	146.24	194.99
.4	48.8221	97.64	146.47	195.29
.5	48.8959	97.79	146.69	195.58
.6	48.9697	97.94	146.91	195.88
.7	49.0436	98.09	147.13	196.17
.8	49.1176	98.23	147.35	196.47
.9	49.1916	98.38	147.57	196.76
133.0	49.2656	98.53	147.80	197.06
.1	49.3397	98.68	148.02	197.36
.2	49.4139	98.83	148.24	197.66
.3	49.4881	98.98	148.46	197.95
.4	49.5624	99.12	148.69	198.25
.5	49.6367	99.27	148.91	198.55
.6	49.7111	99.42	149.13	198.84
.7	49.7856	99.57	149.36	199.14
.8	49.8601	99.72	149.58	199.44
.9	49.9346	99.87	149.80	199.74
134.0	50.0093	100.02	150.03	200.04
.1	50.0839	100.17	150.25	200.34
.2	50.1586	100.32	150.47	200.63
.3	50.2334	100.47	150.70	200.93
.4	50.3083	100.62	150.92	201.23
.5	50.3832	100.77	151.15	201.53
.6	50.4581	100.92	151.37	201.83
.7	50.5331	101.07	151.60	202.13
.8	50.6082	101.22	151.82	202.43
.9	50.6833	101.37	152.05	202.73

DEPTH.				
5	6	7	8	9
242.64	291.16	339.69	388.22	436.74
243.01	291.61	34[illegible].21	388.81	437.41
243.38	292.05	340.73	389.40	438.08
243.74	292.49	341.24	389.98	438.73
244.11	292.93	341.75	390.58	439.40
244.48	293.38	342.27	391.17	440.06
244.85	293.82	342.79	391.76	440.73
245.22	294.26	343.30	392.34	441.39
245.59	294.70	343.82	392.94	442.05
245.96	295.15	344.34	393.53	442.72
246.33	295.59	344.86	394.12	443.39
246.70	296.04	345.38	394.72	444.06
247.07	296.48	345.90	395.31	444.73
247.44	296.93	346.42	395.90	445.39
247.81	297.37	346.93	396.50	446.06
248.19	297.82	347.46	397.10	446.73
248.56	298.27	347.98	397.69	447.40
248.93	298.71	348.50	398.28	448.07
249.30	299.16	349.02	398.88	448.74
249.67	299.60	349.54	399.47	449.41
250.05	300.05	350.06	400.07	450.08
250.42	300.50	350.59	400.67	450.76
250.79	300.95	351.11	401.26	451.42
251.17	301.40	351.63	401.86	452.10
251.54	301.85	352.16	402.46	452.77
251.92	302.30	352.68	403.06	453.45
252.29	302.75	353.21	403.66	454.12
252.67	303.20	353.73	404.26	454.80
253.04	303.65	354.26	404.86	455.47
253.42	304.10	354.78	405.46	456.15

Diam. in Inches.	DEPTH. 1	2	3	4
135.0	50.7584	101.52	152.27	203.03
.1	50.8340	101.67	152.50	203.34
.2	50.9090	101.82	152.73	203.64
.3	50.9842	101.97	152.95	203.94
.4	51.0600	102.12	153.18	204.24
.5	51.1351	102.27	153.41	204.54
.6	51.2110	102.42	153.63	204.84
.7	51.2861	102.57	153.86	205.14
.8	51.3620	102.72	154.09	205.45
.9	51.4374	102.87	154.31	205.75
136.0	51.5132	103.03	154.54	206.05
.1	51.5890	103.18	154.77	206.36
.2	51.6650	103.33	155.00	206.66
.3	51.7410	103.48	155.22	206.96
.4	51.8170	103.63	155.45	207.27
.5	51.8930	103.79	155.68	207.57
.6	51.9690	103.94	155.91	207.88
.7	52.0450	104.09	156.14	208.18
.8	52.1210	104.24	156.36	208.48
.9	52.1972	104.39	156.59	208.79
137.0	52.2740	104.55	156.82	209.10
.1	52.3500	104.70	157.05	209.40
.2	52.4262	104.85	157.28	209.70
.3	52.5030	105.01	157.51	210.01
.4	52.5792	105.16	157.74	210.32
.5	52.6560	105.31	157.97	210.62
.6	52.7324	105.46	158.20	210.93
.7	52.8090	105.62	158.43	211.24
.8	52.8860	105.77	158.66	211.54
.9	52.9630	104.93	158.89	211.8

DEPTH.				
5	6	7	8	9
253.79	304.55	355.31	406.06	456.82
254.17	305.00	355.84	406.67	457.51
254.55	305.45	356.36	407.27	458.18
254.92	305.90	356.89	407.87	458.86
255.30	306.36	357.42	408.48	459.54
255.68	306.81	357.94	409.08	460.22
256.06	307.27	358.48	409.69	460.90
256.43	307.72	359.00	410.29	461.57
256.81	308.17	359.53	410.90	462.26
257.19	308.62	360.06	411.50	462.93
257.57	309.08	360.59	412.10	463.62
257.95	309.53	361.12	412.71	464.30
258.33	309.99	361.66	413.32	464.99
258.71	310.45	362.19	413.93	465.67
259.09	310.90	362.72	414.54	466.35
259.47	311.36	363.25	415.14	467.04
259.85	311.81	363.78	415.75	467.72
260.23	312.27	364.32	416.36	468.41
260.61	312.73	364.85	416.97	469.09
260.99	313.18	365.38	417.58	469.77
261.37	313.64	365.92	418.19	470.47
261.75	314.10	366.45	418.80	471.15
262.13	314.56	366.98	419.41	471.83
262.52	315.02	367.52	420.02	472.53
262.90	315.47	368.05	420.63	473.21
263.28	315.94	368.59	421.25	473.90
263.66	316.39	369.12	421.86	474.59
264.05	316.85	369.66	422.47	475.28
264.43	317.32	370.20	423.09	475.97
264.82	317.78	370.74	423.70	476.67

Diam. in Inches.	DEPTH. 1	2	3	4
138.0	53.0394	106.08	159.12	212.16
.1	53.1164	106.23	159.35	212.46
.2	53.1933	106.39	159.58	212.77
.3	53.2703	106.54	159.81	213.08
.4	53.3474	106.69	160.04	213.39
.5	53.4245	106.85	160.27	213.70
.6	53.5017	107.00	160.51	214.01
.7	53.5789	107.16	160.74	214.32
.8	53.6562	107.31	160.97	214.62
.9	53.7335	107.47	161.20	214.93
139.0	53.8109	107.62	161.43	215.24
.1	53.8884	107.78	161.66	215.55
.2	53.9659	107.93	161.90	215.86
.3	54.0434	108.09	162.13	216.17
.4	54.1211	108.24	162.36	216.48
.5	54.1987	108.40	162.60	216.80
.6	54.2765	108.55	162.83	217.10
.7	54.3543	108.71	163.06	217.42
.8	54.4321	108.86	163.30	217.73
.9	54.5100	109.02	163.53	218.04
140.0	54.5880	109.18	163.76	218.35
.1	54.6660	109.33	164.00	218.66
.2	54.7440	109.49	164.23	218.98
.3	54.8222	109.64	164.47	219.29
.4	54.9003	109.80	164.70	219.60
.5	54.9786	109.96	164.93	219.91
.6	55.0569	110.11	165.17	220.23
.7	55.1352	110.27	165.41	220.54
.8	55.2136	110.43	165.64	220.85
.9	55.2921	110.58	165.88	221.17

DEPTH.				
5	6	7	8	9
265.20	318.23	371.27	424.31	477.35
265.58	318.70	371.81	424.93	478.04
265.97	319.16	372.35	425.54	478.74
266.35	319.62	372.89	426.16	479.43
266.74	320.08	373.43	426.78	480.12
267.12	320.54	373.97	427.39	480.82
267.51	321.01	374.51	428.02	481.52
267.90	321.47	375.05	428.63	482.21
268.28	321.94	375.59	429.25	482.90
268.67	322.40	376.13	429.86	483.60
269.06	322.87	376.68	430.49	484.30
269.44	323.33	377.22	431.10	484.99
269.83	323.80	377.76	431.73	485.69
270.22	324.26	378.30	432.34	486.39
270.61	324.73	378.85	432.97	487.09
271.00	325.19	379.39	433.59	487.79
271.38	325.66	379.93	434.21	488.48
271.77	326.12	380.48	434.83	489.19
272.16	326.59	381.02	435.46	489.89
272.55	327.06	381.57	436.08	490.59
272.94	327.53	382.12	436.70	491.29
273.33	328.00	382.66	437.33	491.99
273.72	328.46	383.21	437.95	492.70
274.11	328.93	383.75	438.58	493.40
274.50	329.40	384.30	439.20	494.10
274.89	329.87	384.85	439.82	494.80
275.29	330.34	385.40	440.46	495.51
275.68	330.81	385.95	441.08	496.22
276.07	331.28	386.49	441.70	496.92
276.46	331.75	387.04	442.34	497.63

Diam. in Inches.	DEPTH. 1	2	3	4
141.0	55.3706	110.74	166.11	221.48
.1	55.4491	110.90	166.35	221.80
.2	55.5278	111.06	166.58	222.11
.3	55.6064	111.21	166.82	222.42
.4	55.6852	111.37	167.06	222.74
.5	55.7640	111.53	167.29	223.06
.6	55.8428	111.69	167.53	223.37
.7	55.9217	111.84	167.77	223.69
.8	56.0007	112.00	168.00	224.00
.9	56.0797	112.16	168.24	224.32
142.0	56.1587	112.32	168.48	224.64
.1	56.2379	112.48	168.71	224.95
.2	56.3170	112.63	168.95	225.27
.3	56.3963	112.79	169.19	225.58
.4	56.4756	112.95	169.43	225.90
.5	56.5549	113.11	169.67	226.22
.6	56.6343	113.27	169.90	226.54
.7	56.7138	113.43	170.14	226.86
.8	56.7933	113.59	170.38	227.17
.9	56.8729	113.75	170.62	227.49
143.0	56.9525	113.90	160.86	227.81
.1	57.0322	114.06	171.10	228.13
.2	57.1119	114.22	171.34	228.45
.3	57.1917	114.38	171.58	228.77
.4	57.2716	114.54	171.81	229.08
.5	57.3515	114.70	172.05	229.40
.6	57.4314	114.85	172.29	229.72
.7	57.5114	115.02	172.53	230.04
.8	57.5915	115.18	172.77	230.36
.9	57.6716	115.34	173.01	230.68

DEPTH.				
5	6	7	8	9
276.85	332.22	387.59	442.96	498.33
277.25	332.69	388.14	443.59	499.04
277.64	333.17	388.70	444.22	499.75
278.03	333.64	389.24	444.85	500.45
278.43	334.11	389.80	445.48	501.17
278.82	334.58	390.35	446.11	501.88
279.22	335.06	390.90	446.74	502.59
279.61	335.53	391.45	447.38	503.30
280.01	336.01	392.01	448.01	504.21
280.40	336.48	392.56	448.64	504.72
280.80	336.95	293.11	449.27	505.43
281.19	337.43	393.67	449.90	506.14
281.59	337.90	394.22	450.54	506.85
281.98	338.38	394.77	451.17	507.56
282.38	338.85	395.33	451.80	508.28
282.78	339.33	395.89	452.44	509.00
283.17	339.80	396.44	453.07	509.71
283.57	340.28	397.00	453.71	510.43
283.97	340.76	397.55	454.34	511.14
284.37	341.24	398.11	454.98	511.86
284.76	341.71	398.56	455.62	512.57
285.16	342.19	399.22	456.26	513.29
285.56	342.67	399.78	456.90	514.01
285.96	343.15	400.34	457.54	514.73
286.36	343.63	400.90	458.17	515.44
286.76	344.11	401.46	458.81	516.16
287.16	344.59	402.02	459.45	516.88
287.56	345.07	402.58	460.09	517.60
287.96	345.55	403.14	460.73	518.32
288.36	346.03	403.70	461.37	519.04

Diam. in Inches.	DEPTH.			
	1	2	3	4
144.0	57.7518	115.50	173.26	231.01
.1	57.8321	115.66	173.50	231.33
.2	57.9124	115.82	173.74	231.65
.3	57.9927	115.99	173.98	231.97
.4	58.0731	116.15	174.22	232.29
.5	58.1536	116.31	174.46	232.61
.6	58.2341	116.47	174.70	232.94
.7	58.3147	116.63	174.95	233.26
.8	58.3953	116.79	175.19	233.58
.9	58.4760	116.95	175.43	233.90
145.0	58.5567	117.11	175.67	234.23
.1	58.6375	117.27	175.91	234.55
.2	58.7184	117.44	176.15	234.87
.3	58.7993	117.60	176.40	235.20
.4	58.8802	117.76	176.64	235.52
.5	58.9613	117.92	176.88	235.84
.6	59.0423	118.08	177.13	236.17
.7	59.1235	118.25	177.37	236.49
.8	59.2047	118.41	177.62	236.82
.9	59.2859	118.57	177.85	237.14
146.0	59.3672	118.73	178.10	237.47
.1	59.4485	118.90	178.34	237.79
.2	59.5299	119.06	178.59	238.12
.3	59.6114	119.22	178.83	238.44
.4	59.6929	119.39	179.08	238.77
.5	59.7745	119.55	179.32	239.10
.6	59.8561	119.71	179.57	239.42
.7	59.9378	119.88	179.81	239.75
.8	60.0196	120.04	180.06	240.08
.9	60.1014	120.20	180.30	240.40

DEPTH.				
5	6	7	8	9
288.76	346.51	404.26	462.02	519.77
289.16	346.99	404.82	462.66	520.49
289.56	347.47	405.38	463.30	521.21
289.97	347.96	405.95	463.94	521.94
290.37	348.44	406.51	464.58	522.66
290.77	348.92	407.07	465.22	523.38
291.17	349.40	407.64	465.87	524.11
291.58	349.89	408.21	466.52	524.84
291.98	350.37	408.77	467.16	525.56
292.38	350.86	409.33	467.81	526.28
292.79	351.34	409.90	468.46	527.01
293.19	351.82	410.46	469.10	527.73
293.59	352.31	411.03	469.74	528.46
294.00	352.79	411.59	470.39	529.19
294.40	353.28	412.16	471.04	529.92
294.81	353.77	412.73	471.69	530.65
295.21	354.25	413.29	472.34	531.38
295.62	354.74	413.86	472.98	532.11
296.03	355.23	414.44	473.64	532.85
296.43	355.72	415.00	474.29	533.57
296.84	356.20	415.57	474.94	534.30
297.24	356.69	416.14	475.58	535.03
297.65	357.18	416.71	476.24	535.77
298.06	357.67	417 28	476.89	536.50
298.47	358.16	417.85	477.54	537.24
298.87	358.64	418.42	478.19	537.97
299.28	359.14	418.99	478.85	538.70
299.69	359.63	419.57	479.50	539.44
300.10	360.11	420.13	480.15	540.17
300.51	360.61	420.71	480.81	540.91

Diam. in Inches.	DEPTH.			
	1	2	3	4
147.0	60.1832	120.37	180.55	240.73
.1	60.2651	120.53	180.80	241.06
.2	60.3471	120.69	181.04	241.39
.3	60.4291	120.86	181.29	241.72
.4	60.5112	121.02	181.53	242.04
.5	60.5933	121.19	181.78	242.37
.6	60.6755	121.35	182.03	242.70
.7	60.7578	121.51	182.27	243.03
.8	60.8401	121.68	182.52	243.36
.9	60.9224	121.84	182.77	243.69
148.0	61.0048	122.01	183.01	244.02
.1	61.0873	122.17	183.26	244.35
.2	61.1698	122.34	183.51	244.68
.3	61.2524	122.50	183.76	245.01
.4	61.3350	122.67	184.01	245.34
.5	61.4177	122.83	184.25	245.67
.6	61.5005	123.00	184.50	246.00
.7	61.5833	123.17	184.75	246.33
.8	61.6661	123.33	185.00	246.66
.9	61.7490	123.50	185.25	247.00
149.0	61.8320	123.66	185.50	247.33
.1	61.9150	123.83	185.75	247.66
.2	61.9981	124.00	185.99	247.99
.3	62.0812	124.16	186.24	248.32
.4	62.1644	124.33	186.49	248.66
.5	62.2477	124.49	186.74	248.99
.6	62.3310	124.66	186.99	249.32
.7	62.4148	124.83	187.24	249.66
.8	62.4978	124.99	187.49	249.99
.9	62.5812	125.16	187.74	250.32

DEPTH.				
5	6	7	8	9
300.92	361.10	421.28	481.46	541.65
301.33	361.59	421.86	482.12	542.39
301.74	362.08	422.43	482.78	543.12
302.15	362.57	423.00	483.43	543.86
302.56	363.07	423.58	484.09	544.60
302.96	363.56	424.15	484.74	545.34
303.38	364.05	424.73	485.40	546.08
303.79	364.54	425.30	486.06	546.81
304.20	365.04	425.88	486.72	547.56
304.61	365.53	426.45	487.38	548.30
305.02	366.02	427.03	488.03	549.04
305.44	366.52	427.61	488.70	549.78
305.85	367.01	428.18	489.35	550.52
306.26	367.51	428.76	490.02	551.26
306.68	368.01	429.35	490.68	552.02
307.09	368.50	429.92	491.34	552.75
307.50	369.00	430.50	492.00	553.50
307.92	369.50	431.08	492.66	554.25
308.33	370.00	431.66	493.33	554.99
308.75	370.49	432.24	493.99	555.74
309.16	370.99	432.82	494.66	556.49
309.58	371.49	433.41	495.32	557.24
309.99	371.99	433.99	495.98	557.98
310.41	372.49	434.57	496.65	558.73
310.82	372.98	435.15	497.31	559.48
311.24	373.48	435.73	497.98	560.22
311.66	373.99	436.32	498.65	560.98
312.07	374.48	436.90	499.31	561.73
312.49	374.98	437.48	499.98	562.47
312.91	375.49	438.07	500.65	563.23

Diam. in Inches.	DEPTH.			
	1	2	3	4
150.0	62.6648	125.33	187.99	250.66
.1	62.7483	125.50	188.24	250.99
.2	62.8320	125.65	188.50	251.33
.3	62.9157	125.83	188.75	251.66
.4	62.9994	126.00	189.00	252.00
.5	63.0832	126.17	189.25	252.33
.6	63.1671	126.33	189.50	252.67
.7	63.2510	126.50	189.75	253.00
.8	63.3350	126.67	190.01	253.34
.9	63.4190	126.84	190.26	253.68
151.0	63.5030	127.01	190.51	254.01
.1	63.5872	127.17	190.76	254.35
.2	63.6714	127.34	191.01	254.68
.3	63.7556	127.51	191.27	255.02
.4	63.8400	127.68	191.52	255.36
.5	63.9243	127.85	191.77	255.70
.6	64.0087	128.02	192.02	256.03
.7	64.0932	128.19	192.28	256.37
.8	64.1777	128.35	192.53	256.71
.9	64.2623	128.52	192.79	257.05
152.0	64.3470	128.69	193.04	257.39
.1	64.4316	128.85	193.29	257.72
.2	64.5164	129.03	193.55	258.06
.3	64.6012	129.20	193.80	258.40
.4	64.6861	129.37	194.06	258.74
.5	64.7710	129.54	194.31	259.08
.6	64.8560	129.71	194.57	259.42
.7	64.9410	129.88	194.82	259.76
.8	65.0261	130.05	195.08	260.10
.9	65.1112	130.22	195.33	260.44

DEPTH.				
5	6	7	8	9
313.32	375.98	438.65	501.31	563.98
313.74	376.49	439.24	501.98	564.73
314.16	376.99	439.82	502.66	565.49
314.58	377.49	440.41	503.32	566.24
315.00	377.89	440.89	503.89	566.99
315.42	378.50	441.58	504.66	567.75
315.84	379.00	442.17	505.34	568.50
316.26	379.51	442.76	506.01	569.26
316.68	380.01	443.35	506.68	570.02
317.10	380.51	443.93	507.35	570.77
317.52	381.02	444.52	508.02	571.53
317.94	381.52	445.11	508.70	572.28
318.36	382.03	445.70	509.37	573.04
318.78	382.53	446.29	510.04	573.80
319.20	383.04	446.88	510.72	574.56
319.62	383.54	447.47	511.39	575.32
320.04	384.05	448.06	512.06	576.07
320.47	384.56	448.65	512.74	576.84
320.89	385.06	449.24	513.42	577.59
321.31	385.57	449.83	514.10	578.36
321.74	386.08	450.43	514.78	579.12
322.16	386.59	451.02	515.45	579.88
322.58	387.10	451.61	516.13	580.64
323.01	387.61	452.21	516.81	581.41
323.43	388.12	452.80	517.49	582.17
323.86	388.63	453.40	518.17	582.94
324.28	389.14	453.99	518.85	583.70
324.71	389.65	454.59	519.53	584.47
325.13	390.16	455.18	520.21	585.23
325.56	390.67	455.78	520.89	586.00

Diam. in Inches.	DEPTH. 1	2	3	4
153.0	65.1964	130.39	195.59	260.78
.1	65.2817	130.56	195.84	261.12
.2	65.3670	130.73	196.10	261.47
.3	65.4523	130.90	196.36	261.81
.4	65.5377	131.07	196.61	262.15
.5	65.6232	131.25	196.87	262.49
.6	65.7088	131.42	197.12	262.83
.7	65.7943	131.59	197.38	263.18
.8	65.8800	131.76	197.64	263.52
.9	65.9657	131.93	197.90	263.86
154.0	66.0514	132.10	198.15	264.20
.1	66.1372	132.27	198.41	264.55
.2	66.2231	132.45	198.67	264.89
.3	66.3090	132.62	198.93	265.24
.4	66.3950	132.79	199.19	265.58
.5	66.4810	132.96	199.44	265.92
.6	66.5671	133.13	199.70	266.27
.7	66.6533	133.31	199.96	266.61
.8	66.7395	133.48	200.22	266.96
.9	66.8257	133.65	200.48	267.30
155.0	66.9120	133.82	200.74	267.65
.1	66.9984	134.00	200.99	267.99
.2	67.0848	134.17	201.25	268.34
.3	67.1713	134.34	201.51	268.68
.4	67.2578	134.51	201.77	269.03
.5	67.3444	134.69	202.03	269.38
.6	67.4311	134.86	202.29	269.72
.7	67.5178	135.03	202.55	270.07
.8	67.6045	135.21	202.81	270.42
.9	67.6913	135.38	203.07	270.76

DEPTH.				
5	6	7	8	9
325.98	391.18	456.37	521.57	586.76
326.41	391.69	456.97	522.25	587.53
326.84	392.20	457.57	522.94	588.30
327.26	392.71	458.16	523.62	589.07
327.69	393.22	458.76	524.30	589.83
328.12	393.73	459.36	524.98	59 .61
328.54	394.24	459.96	525.66	591.37
328.97	394.76	460.56	526.35	592.15
329.40	395.28	461.16	527.04	592.92
329.83	395.79	461.76	527.72	593.69
330.26	296.31	462.36	528.41	594.46
330.69	396.82	462.96	529.10	595.23
331.12	397.34	463.56	529.78	596.01
331.55	397.85	464.16	530.47	596.78
331.98	398.37	464.77	531.16	597.56
332.41	398.89	465.37	531.85	598.33
332.84	399.40	465.97	532.54	599.10
333.27	399.92	466.57	533.22	599.88
333.70	400.43	467.17	533.91	600.65
334.13	400.95	467.78	534.60	601.43
334.56	401.47	468.38	535.30	602.21
334.99	401.99	468.99	535.98	602.98
335.42	402.50	469.59	536.67	603.76
335.86	403.03	470.20	537.37	604.54
336.29	403.54	470.80	538.06	605.31
336.72	404.06	471.41	538.75	606.10
337.16	404.59	472.02	539.45	606.88
337.59	405.10	472.62	540.14	607.65
338.02	405.62	473.23	540.83	608.44
338.46	406.15	473.84	541.53	609.22

A TABLE *for Reducing of Gallons into*

Gallons.	Beer.		Ale.			Gallons.	Beer.		Ale.		
	B.	F.	B.	F.	G.		B.	F.	B.	F.	G
36	1	0	1	0	4	360	10	0	11	1	0
45	1	1	1	1	5	369	10	1	11	2	1
54	1	2	1	2	6	378	10	2	11	3	2
63	1	3	1	3	7	387	10	3	12	0	3
72	2	0	2	1	0	396	11	0	12	1	4
81	2	1	2	2	1	405	11	1	12	2	5
90	2	2	2	3	2	414	11	2	12	3	6
99	2	3	3	0	3	423	11	3	13	0	7
108	3	0	3	1	4	432	12	0	13	2	0
117	3	1	3	2	5	441	12	1	13	3	1
126	3	2	3	3	6	450	12	2	14	0	2
135	3	3	4	0	7	459	12	3	14	1	3
144	4	0	4	2	0	468	13	0	14	2	4
153	4	1	4	3	1	477	13	1	14	3	5
162	4	2	5	0	2	486	13	2	15	0	6
171	4	3	5	1	3	495	13	3	15	1	7
180	5	0	5	2	4	504	14	0	15	3	0
189	5	1	5	3	5	513	14	1	16	0	1
198	5	2	6	0	6	522	14	2	16	1	2
207	5	3	6	1	7	531	14	3	16	2	3
216	6	0	6	3	0	540	15	0	16	3	4
225	6	1	7	0	1	549	15	1	17	0	5
234	6	2	7	1	2	558	15	2	17	1	6
243	6	3	7	2	3	567	15	3	17	2	7
252	7	0	7	3	4	576	16	0	18	0	0
261	7	1	8	0	5	585	16	1	18	1	1
270	7	2	8	1	6	594	16	2	18	2	2
279	7	3	8	2	7	603	16	3	18	3	3
288	8	0	9	0	0	612	17	0	19	0	4
297	8	1	9	1	1	621	17	1	19	1	5
306	8	2	9	2	2	630	17	2	19	2	6
315	8	3	9	3	3	639	17	3	19	3	7
324	9	0	10	0	4	648	18	0	20	1	0
333	9	1	10	1	5	657	18	1	20	2	1
342	9	2	10	2	6	666	18	2	20	3	2
351	9	3	10	3	7	675	18	3	21	0	3

25

Gallons.	Beer.		Ale.			Gallons.	Beer.		Ale.		
	B.	F.	B.	F.	G.		B.	F.	B.	F.	G.
684	19	0	21	1	4	1008	28	0	31	2	0
693	19	1	21	2	5	1017	28	1	31	3	1
702	19	2	21	3	6	1026	28	2	32	0	2
711	19	3	22	0	7	1035	28	3	32	1	3
720	20	0	22	2	0	1044	29	0	32	2	4
729	20	1	22	3	1	1053	29	1	32	3	5
738	20	2	23	0	2	1062	29	2	33	0	6
747	20	3	23	1	3	1071	29	3	33	1	7
756	21	0	23	2	4	1080	30	0	33	3	0
765	21	1	23	3	5	1089	30	1	34	0	1
774	21	2	24	0	6	1098	30	2	34	1	2
783	21	3	24	1	7	1107	30	3	34	2	3
792	22	0	24	3	0	1116	31	0	34	3	4
801	22	1	25	0	1	1125	31	1	35	0	5
810	22	2	25	1	2	1134	31	2	35	1	6
819	22	3	25	2	3	1143	31	3	35	2	7
828	23	0	25	3	4	1152	32	0	36	0	0
837	23	1	26	0	5	1161	32	1	36	1	1
846	23	2	26	1	6	1170	32	2	36	2	2
855	23	3	26	2	7	1179	32	3	36	3	3
864	24	0	27	0	0	1188	33	0	37	0	4
873	24	1	27	1	1	1197	33	1	37	1	5
882	24	2	27	2	2	1206	33	2	37	2	6
891	24	3	27	3	3	1215	33	3	37	3	7
900	25	0	28	0	4	1224	34	0	38	1	0
909	25	1	28	1	5	1233	34	1	38	2	1
918	25	2	28	2	6	1242	34	2	38	3	2
927	25	3	28	3	7	1251	34	3	39	0	3
936	26	0	29	1	0	1260	35	0	39	1	4
945	26	1	29	2	1	1296	36	0	40	2	0
954	26	2	29	3	2	1332	37	0	41	2	4
963	26	3	30	0	3	1368	38	0	42	3	0
972	27	0	30	1	4	1404	39	0	43	3	4
981	27	1	30	2	5	1440	40	0	45	0	0
990	27	2	30	3	6	2880	80	0	90	0	0
999	27	3	31	0	7	5760	160	0	180	0	0

FINIS.

ERRATA's in the TABLE.

Diam.	Depth.	Errors.	Corrected.
51.5	1	7.3869	7.3868
59.1	6	58.46	58.37
61.9	6	63.04	64.03
62.9	1	10.0190	11.0190
67.5	8	101.56	101.51
71.9	7	100.79	100.78
94.2	7	172.99	173.00
101.2	6	170.14	171.14
128.9	4	145.10	185.10
138.3	9	49.43	479.43